INTERNATIONAL STANDARD

IEC 60384-14

QC 302400

Third edition
2005-07

Fixed capacitors for use in electronic equipment –

Part 14:
Sectional specification:
Fixed capacitors for electromagnetic interference suppression and connection to the supply mains

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International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains

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 60384-14 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This third edition cancels and replaces the second edition published in 1993 and amendment 1 (1995). It constitutes a technical revision. All changes that have been agreed upon can be categorized as minor revisions.

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

FDIS	Report on voting
40/1552/FDIS	40/1586/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.

IEC 60384 consists of the following parts, under the general title *Fixed capacitors for use in electronic equipment:*

Part 1: Generic specification

Part 2: Sectional specification: Fixed metallized polyethylene-terephthalate film dielectric d.c. capacitors

Part 3: Sectional specification: Fixed tantalum chip capacitors

Part 4: Sectional specification: Aluminium electrolytic capacitors with solid and non-solid electrolyte

Part 5: Sectional specification: Fixed mica dielectric d.c. capacitors with a rated voltage not exceeding 3 000 V - Selection of methods of test and general requirements

Part 6: Sectional specification: Fixed metallized polycarbonate film dielectric d.c. capacitors

Part 7: Sectional specification: Fixed polystyrene film dielectric metal foil d.c. capacitors

Part 8: Sectional specification: Fixed capacitors of ceramic dielectric, Class 1

Part 9: Sectional specification: Fixed capacitors of ceramic dielectric, Class 2

Part 11: Blank detail specification: Fixed polyethylene-terephthalate film dielectric metal foil d.c. capacitors – Assessment level E

Part 12: Sectional specification: Fixed polycarbonate film dielectric metal foil d.c. capacitors

Part 13: Sectional specification: Fixed polypropylene film dielectric metal foil d.c. capacitors

Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains

Part 15: Sectional specification: Fixed tantalum capacitors with non-solid or solid electrolyte

Part 16: Sectional specification: Fixed metallized polypropylene film dielectric d.c. capacitors

Part 17: Sectional specification: Fixed metallized polypropylene film dielectric a.c. and pulse capacitors

Part 18: Sectional specification: Fixed aluminium electrolytic chip capacitors with solid and non-solid electrolyte

Part 19: Sectional specification: Fixed metallized polyethylene-terephthalate film dielectric chip d.c. capacitors

Part 20: Sectional specification: Fixed metallized polyphenylene sulfide film dielectric chip d.c. capacitors

Part 21: Sectional specification: Fixed surface mount multilayer capacitors of ceramic dielectric, Class 1

Part 22: Sectional specification: Fixed surface mount multilayer capacitors of ceramic dielectric, Class 2

The QC number that appears on the front cover of this publication is the specification number in the IEC Quality Assessment System for Electronic Components (IECQ).

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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.

A bilingual version of this standard may be issued at a later date.

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains

1 General

1.1 Scope

This part of IEC 60384 applies to capacitors and resistor-capacitor combinations which will be connected to an a.c. mains or other supply with nominal voltage not exceeding 1 000 V a.c. (r.m.s.) or 1 000 V d.c. and with a nominal frequency not exceeding 100 Hz.

1.2 Object

The principal object of this standard is to prescribe preferred ratings and characteristics and to select from IEC 60384-1, the appropriate quality assessment procedures, tests and measuring methods and to give general performance requirements for this type of capacitor. Test severities and requirements prescribed in detail specifications referring to this sectional specification shall be of equal or higher performance level, lower performance levels not being permitted.

A further object of this standard is to provide a schedule of safety tests to be used by national testing stations in countries where approval by such stations is required.

1.3 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 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60063, *Preferred number series for resistors and capacitors*

IEC 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-17, *Environmental testing – Part 2: Tests – Test Q: Sealing*

IEC 60335-1, *Household and similar electrical appliances – Safety – Part 1: General requirements*

IEC 60384-1, *Fixed capacitors for use in electronic equipment – Part 1: Generic specification*

IEC 60384-14-4, *Fixed capacitors for use in electronic equipment – Part 14: Blank detail specification: Fixed capacitors for electromagnetic interference supply and connection to the supply mains – Assessment level D*

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60760, *Flat, quick-connect terminations*

IEC 60940, *Guidance information on the application of capacitors, resistors, inductors and complete filter units for radio interference suppression*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

CISPR 17, *Methods of measurement of the suppression characteristics of passive radio interference filters and suppression components*

IEC QC 001005, *IEC Quality Assessment System for Electronic Components (IECQ) – Register of Firms, Products and Services approved under the IECQ System, including ISO 9000*

ISO 7000-DB[1], *Graphical symbols for use on equipment – Index and synopsis*

1.4 Information to be given in a detail specification

Detail specifications shall be derived from the relevant blank detail specification.

Detail specifications shall not specify requirements inferior to those of the generic, sectional or blank detail specification. When more severe requirements are included, they shall be listed in 1.9 of the detail specification, and indicated in the test schedules, for example, by an asterisk.

The following information shall be given in each detail specification and the values quoted shall preferably be selected from the appropriate clause of this sectional specification.

NOTE The information given in 1.4.1 may for convenience be presented in tabular form.

1.4.1 Outline drawing and dimensions

There shall be an illustration of the capacitor as an aid to easy recognition and for comparison of the capacitor with others. Dimensions and their associated tolerances, which affect interchangeability and mounting, shall be given in the detail specification. All dimensions shall preferably be stated in millimetres; however, when the original dimensions are given in inches, the converted metric dimensions in millimetres shall be added.

Normally, the numerical values shall be given for the length, width and height of the body and the wire spacing, or for cylindrical types, the body diameter and the length and diameter of the terminations. When necessary, for example when a number of capacitance values/voltage ranges are covered by a detail specification, their dimensions and their associated tolerances shall be placed in a table below the drawing.

When the configuration is other than that described above, the detail specification shall state such dimensional information as will adequately describe the capacitor. When the capacitor is not designed for use on printed boards, this shall be clearly stated in the detail specification.

1.4.2 Mounting

The detail specification shall specify the method of mounting to be applied for normal use and for the application of the vibration, bump or shock tests. The capacitors shall be mounted by their normal means. The design of the capacitor may be such that special mounting fixtures are required in its use. In this case, the detail specification shall describe the mounting fixtures and they shall be used in the application of the vibration, bump or shock tests.

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1 DB refers to the ISO on-line database.

NOTE If recommendations for mounting for "normal" use are made, they should be included in the detail specification under "1.8 Additional information (Not for inspection purposes)". If recommendations are included, a warning can be given that the full vibration, bump and shock performance may not be available if mounting methods other than those specified in 1.1 of the detail specification are used.

1.4.3 Ratings and characteristics

The ratings and characteristics shall be in accordance with the relevant clauses of this specification, together with the following.

1.4.3.1 Rated capacitance range

See 2.2.1.

NOTE When products approved to the detail specification have different ranges, the following statement should be added: "The range of values available in each voltage range is given in IEC QC 001005."

1.4.3.2 Rated resistance range (if applicable)

See 2.2.4.

1.4.3.3 Particular characteristics

Additional characteristics may be listed, when they are considered necessary to specify the component adequately for design and application purposes.

1.4.4 Marking

The detail specification shall specify the content of the marking on the capacitor and on the package. See also 1.6 of this specification.

1.5 Terms and definitions

For the purposes of this document, the terms and definitions of IEC 60384-1, as well as the following, apply.

NOTE Some definitions of IEC 60384-1 have been expanded, and this is indicated by reference to this note.

1.5.1
a.c. capacitor
capacitor designed essentially for application with a power-frequency alternating voltage

NOTE AC capacitors may be used on d.c. supplies having the same voltage as the a.c. r.m.s. rated voltage of the capacitor.

1.5.2
electromagnetic interference suppression capacitor (radio interference suppression capacitor)
capacitor used for the reduction of electromagnetic interference caused by electrical or electronic apparatus, or other sources

1.5.3
capacitor or RC unit of Class X
capacitor or RC unit of a type suitable for use in situations where failure of the capacitor or RC unit would not lead to danger of electrical shock but could result in a risk of fire

Class X capacitors are divided into three subclasses (see Table 1) according to the peak voltage of the impulses superimposed on the mains voltage to which they may be subjected in service. Such impulses may arise from lightning strikes on outside lines, from switching in neighbouring equipment, or switching in the equipment in which the capacitor is used.

Table 1 – Classification of Class X capacitors

Subclass	Peak impulse voltage in service	IEC 60664-1 installation category	Application	Peak impulse voltage U_p applied before endurance test
X1	> 2,5 kV ≤ 4,0 kV	III	High pulse application	When $C_R \leq 1{,}0\ \mu F$ $U_P = 4$ kV When $C_R > 1{,}0\ \mu F$ $U_P = \frac{4}{\sqrt{\frac{C_R}{10^{-6}\ F}}}$ kV
X2	≤ 2,5 kV	II	General purpose	When $C_R \leq 1{,}0\ \mu F$ $U_P = 2{,}5$ kV When $C_R > 1{,}0\ \mu F$ $U_P = \frac{2{,}5}{\sqrt{\frac{C_R}{10^{-6}\ F}}}$ kV
X3	≤ 1,2 kV	-	General purpose	None
NOTE The factor used for the reduction of U_P for capacitance values above 1,0 µF maintains ½ × $C_R U_P^2$ constant for these capacitance values; C_R is in F.				

1.5.4
capacitor or RC unit of Class Y
capacitor or RC unit of a type suitable for use in situations where failure of the capacitor could lead to danger of electric shock

Class Y capacitors are further divided into four subclasses, Y1, Y2, Y3 and Y4, as shown in Table 2.

Table 2 – Classification of Class Y capacitors

Subclass	Type of insulation bridged	Range of rated voltages	Peak impulse voltage before endurance test
Y1	Double insulation or reinforced insulation	≤ 500 V	8,0 kV
Y2	Basic insulation or supplementary insulation	≥ 150 V ≤ 300 V	5,0 kV
Y3	Basic insulation or supplementary insulation	≥ 150 V ≤ 250 V	None
Y4	Basic insulation or supplementary insulation	< 150 V	2,5 kV
NOTE 1 For definitions of basic, supplementary, double and reinforced insulation, see IEC 61140. NOTE 2 Y2 capacitors may be substituted by Y1 capacitors of the same or higher U_R.			

The enclosure of a Y1-capacitor shall not contain other components. Assemblies may be constructed from Y-capacitors and X-capacitors provided these capacitors fulfil the requirements for the relevant X and Y subclasses.

One Y-capacitor may bridge basic insulation. One Y-capacitor may bridge supplementary insulation. If combined basic and supplementary insulations are bridged by two Y2-, Y3- or Y4-capacitors in series, they shall have the same nominal value.

NOTE If insulated terminals are requested, the preferable colours should be transparent or white.

1.5.5
two-terminal capacitor
electromagnetic interference suppression capacitor having two terminals (see Figure 1)

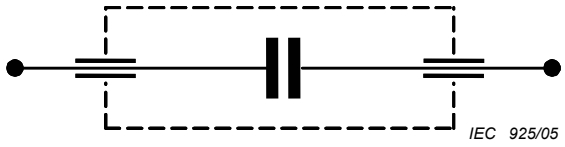

Figure 1 – Two-terminal capacitor

1.5.6
series RC unit
functional combination of a resistor in series with a capacitor of Class X or Y (see Figure 2)

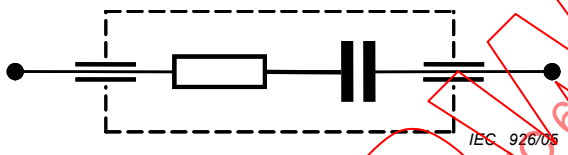

Figure 2 – RC unit

NOTE In this standard, where the word "capacitor" appears, the words "capacitor or RC unit" should be understood where the context permits.

1.5.7
lead-through capacitor (coaxial)
capacitor with a central current-carrying conductor surrounded by a capacitor element which is symmetrically bonded to the central conductor and to the outer casing to form a coaxial construction.

It should be mounted coaxially (see Figure 3)

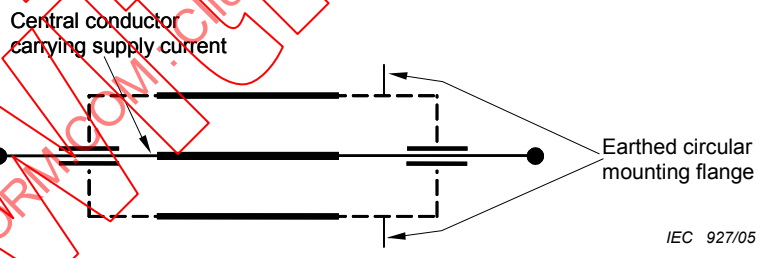

Figure 3 – Lead-through capacitor (coaxial)

1.5.8
lead-through capacitor (non-coaxial)
capacitor in which the supply currents flow through or across the electrodes (see Figures 4a, 4b, 4c and 4d)

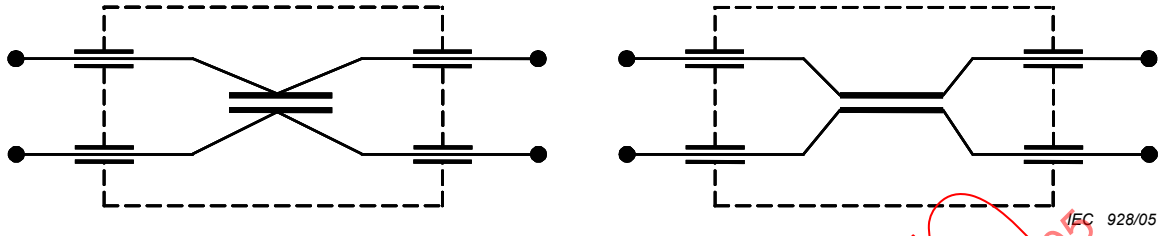

Figure 4a – Lead-through capacitor for symmetrical use (non-coaxial)

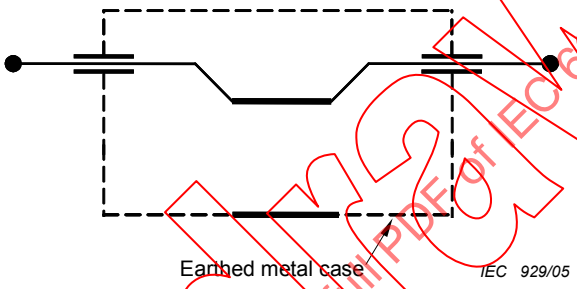

Figure 4b – Lead-through capacitor for asymmetrical use (non-coaxial)

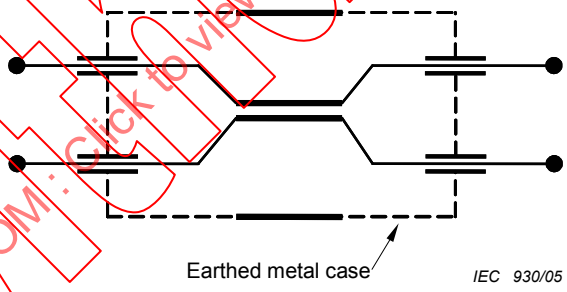

Figure 4c – Multiple unit lead-through capacitor (non-coaxial) for symmetrical and asymmetrical use

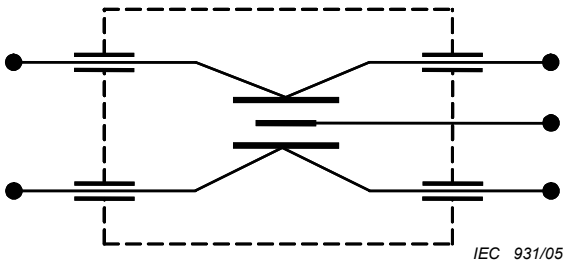

Figure 4d – Multiple unit lead-through capacitor

Figure 4 – Lead-through capacitors

1.5.9
by-pass capacitor
capacitor where radiofrequency interference currents are by-passed. There are three common forms: single, delta and T-connected. The single capacitor consists of a capacitor in a metal case with one termination connected to the case as in Figure 5a; the delta form consists of an X-capacitor and two Y2- or Y3-capacitors arranged in a delta network as in Figure 5b; the T-connected form consists of three capacitors C_A, C_B and C_C connected in T as shown in Figure 5c.

The delta and T-connected forms are electrically equivalent (star-delta transformation). In the T-connected form the X-capacitor is the result of the series connection of $C_B - C_C$ and the Y-capacitors are the results of the series connections of $C_A - C_B$ and $C_A - C_C$.

When T-connected capacitors are submitted to tests, and it is stated that voltages shall be applied across the X-capacitors, such voltages shall be applied between the line and neutral terminations. Similarly, when it is stated that voltages shall be applied across the Y-capacitors, such voltages shall be applied between the line and neutral terminations connected together and the earth termination.

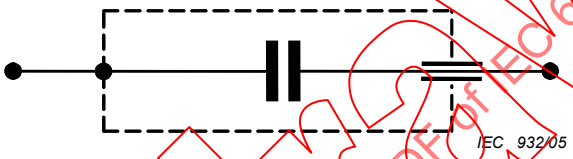

Figure 5a – Single by-pass capacitor

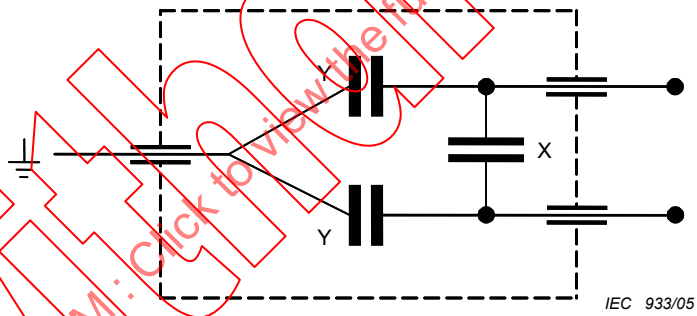

Figure 5b – Delta by-pass capacitor

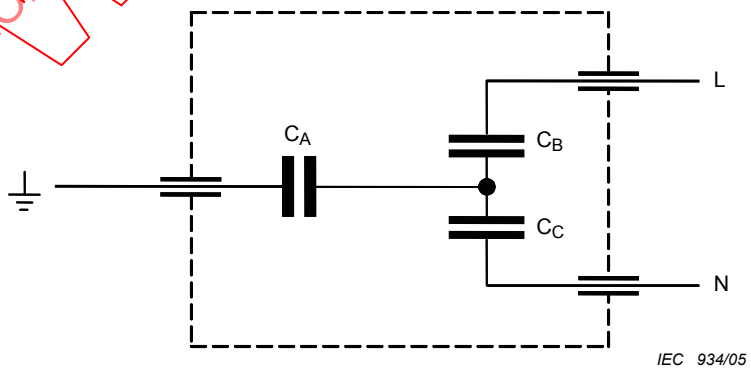

Figure 5c – Example of a T-connected by-pass capacitor

NOTE For capacitors with non-metallic housings, the earth connection is brought out as a separate termination.

Figure 5 – By-pass capacitors

1.5.10
rated voltage
either the r.m.s. operating voltage of rated frequency, or the d.c. operating voltage, which may be applied continuously to the terminations of a capacitor at any temperature between the lower and the upper category temperatures.

This implies, for capacitors covered by this specification, that the category voltage is the same as the rated voltage

1.5.11
rated power (of a series RC unit)
maximum power which can be dissipated by the RC unit at the rated temperature during continuous operation

1.5.12
upper category temperature
maximum surface temperature for which the capacitor has been designed to operate continuously (see note to 1.5)

NOTE 1 For lead-through capacitors and series RC units, the external surface temperature can be affected by internal heating due to the lead-through current. The terminations of a capacitor are considered to be part of the external surface.

NOTE 2 This definition replaces that given in IEC 60384-1, 2.2.14, because suppression capacitors in accordance with this specification are intended to be connected to the mains network and may have internal heat generation as a result.

1.5.13
lower category temperature
minimum surface temperature for which the capacitor has been designed to operate continuously (see note to 1.5)

NOTE This definition replaces that given in IEC 60384-1, 2.2.13 (see note 2 to 1.5.12 above).

1.5.14
rated temperature (of a lead-through capacitor or series RC unit)
maximum ambient temperature at which a lead-through capacitor can carry its rated lead-through current or a series RC unit can dissipate its rated power

NOTE This definition replaces that in IEC 60384-1, 2.2.15 (see note 2 to 1.5.12 above).

1.5.15
insertion loss
ratio of the voltage before and after the insertion of the suppressor as measured at the terminations

NOTE When measured in decibels, the insertion loss is 20 times the logarithm to base 10 of the ratio stated.

1.5.16
rated current of the conductors (lead-through capacitor)
maximum permissible current flowing through the conductors of the capacitor at the rated temperature during continuous operation

1.5.17
main resonant frequency (two-terminal capacitor)
lowest frequency at which the impedance of the capacitor is a minimum when applying a sinusoidal voltage

1.5.18
impulse voltage
aperiodic transient voltage of a defined waveform as described in IEC 60060-1

1.5.19
passive flammability
ability of a capacitor to burn with a flame as a consequence of the application of an external source of heat

1.5.20
active flammability
ability of a capacitor to burn with a flame as a consequence of electrical loading

1.6 Marking

According to 2.4 of IEC 60384-1, with the following details.

The information given in the marking is normally selected from the following list; the relative importance of each item is indicated by its position in the list:

a) manufacturer's name or trademark;
b) manufacturer's type designation or the type designation given in the detail specification;
c) capacitor class and subclass;
d) recognized approval mark;
e) rated capacitance(s) and rated resistance;
f) rated voltage and nature of supply (alternating voltage may be indicated by the symbol ~ and direct voltage by the symbol ⎓ or ⎓);
g) the method of connection, if necessary;
h) rated current of the conductor (in the case of a lead-through capacitor);
i) tolerance on rated capacitance if different from ±20 %;
j) climatic category, followed by a letter indicating passive flammability category;
k) rated temperature;
l) year and month (or week) of manufacture;
m) reference to the detail specification.

1.6.1 The capacitor shall be clearly marked with a), b) and c) and also d), e) and f) if these are not implied by b), and as many of the remaining items as are considered necessary by the manufacturer. The marking shall be sufficient to enable a clear identification of the component to be made.

NOTE For surface-mount components only a) and b) are mandatory (see Annex F).

It is recommended that a caution mark be printed on the pc board where a safety component is mounted. The caution mark shall be ISO 7000-0434 (DB:2004-01). The mark is in the form of an upright equilateral triangle containing an exclamation mark.

NOTE This caution mark is referred to in 5.3 of IEC 60065:2001.Any duplication of information in the marking on the capacitor should be avoided.

1.6.2 The package containing the capacitor(s) shall be clearly marked with all the information listed above. National approvals may be indicated by lettering as an alternative to the approval mark.

1.6.3 Any additional marking shall be applied in such a way that no confusion can arise.

2 Preferred ratings and characteristics

2.1 Preferred characteristics

The values given in detail specifications shall preferably be selected from the following.

2.1.1 Preferred climatic categories

The capacitors covered by this specification are classified into climatic categories according to the general rules given in IEC 60068-1.

The lower and upper category temperature and the duration of the damp-heat steady-state test shall be chosen from the following:

lower category temperature: -65 °C, -55 °C, -40 °C, -25 °C and -10 °C;

upper category temperature: +85 °C, +100 °C, +105 °C, +125 °C and +155 °C;

duration of the damp-heat steady-state test: 21 and 56 days.

The severities for the cold and dry-heat tests are the lower and upper category temperatures respectively.

For guidance on the application of the categories described above, see IEC 60940.

2.2 Preferred values of ratings

2.2.1 Rated capacitance (C_R)

The preferred values of rated capacitance are:

1 – 1,5 – 2,2 – 3,3 – 4,7 – 6,8 and their decimal multiples.

These values conform to the E6 series of preferred values given in IEC 60063.

2.2.2 Tolerance on rated capacitance

The maximum tolerance on rated capacitance is ±20 %.

2.2.3 Rated voltage (U_R)

The preferred values of rated voltage are 125 V, 250 V, 275 V, 400 V, 440V, 500 V and 760 V.

NOTE 1 X-capacitors can be used in a star connect.

NOTE 2 Electromagnetic interference suppression capacitors should be chosen to have a rated voltage equal to, or greater than, the nominal voltage of the supply system to which they are connected. The design of the capacitors should take into account the possibility that the voltage of the system may rise by up to 10,% above its nominal voltage.

2.2.4 Rated resistance (R_R)

Preferred values of rated resistance shall be taken from the E6 series of IEC 60063.

2.2.5 Rated temperature

The rated temperature for lead-through capacitors and series RC units shall be not less than +40 °C.

2.2.6 Passive flammability

The minimum category of passive flammability permitted is Category C (see 4.17).

3 Assessment procedures

3.1 Primary stage of manufacture

For wound capacitors, the primary stage of manufacture is the winding of the capacitor element. For single-layer ceramic capacitors, it is the metallization of the dielectric to form the electrodes. For fixed multilayer ceramic capacitors, it is the first common firing of the dielectric-electrode assembly. For other types of capacitor, it shall be the same as that given in the sectional specification for the dielectric used.

3.2 Structurally similar components

Capacitors considered as being structurally similar are capacitors produced with essentially the same processes and materials, though they may be of different case sizes and capacitance values, but of the same class and rated voltage.

3.3 Certified records of released lots

The information required in 3.10 of IEC 60384-1 shall be made available when prescribed in the detail specification and when requested by a customer. After the endurance test the parameters for which variables information is required are capacitance change, resistance change (for RC units), tan δ and insulation resistance.

3.4 Approval testing

3.4.1 Safety tests only approval

Tables 3 and 6 form a schedule limited to tests concerning safety only requirements. The schedule to be used for safety tests only approval will be on the basis of fixed sample sizes as given in 3.4.3 and Table 3 of this specification. Prior to the approval testing being carried out, it is necessary to submit to the certification body a declaration of design (see Annex D) registering essential data and basic design details of the capacitors for which approval is sought.

3.4.2 Qualification approval

Tables 4, 5 and 7 shall be used when qualification approval is sought.

The procedures for qualification approval testing are given in the generic specification, IEC 60384-1, 3.5, in which 3.5.3a) refers to lot-by-lot and periodic inspections. The schedules to be used for qualification approval testing on the basis of lot-by-lot and periodic inspections are given in 3.5 and Table 8 of this specification. The schedule to be used for qualification approval testing on the basis of fixed sample sizes according to 3.5.3b) of IEC 60384-1 is given in 3.4.3 and Tables 4 and 5 of this specification. For the two procedures, the sample sizes and the number of permissible nonconforming items shall be of comparable order. The test conditions and requirements shall be the same. Qualification approval according to the fixed sample sizes of Tables 4 and 5 is preferred.

3.4.3 Qualification approval on the basis of the fixed sample size procedure

3.4.3.1 Sampling

Capacitors of each technology, rated voltage, class and subclass shall be separately qualified. The total number of capacitors of each rated voltage in each group is given in Tables 3, 4 and 5. For multi-section capacitors containing sections of different classes and for lead-through capacitors, larger numbers are required as indicated.

The sample shall contain equal numbers of specimens of the highest and lowest capacitance values in the range to be qualified, except for the passive flammability test of 4.17 and the active flammability test of 4.18. For the passive flammability test, the rules of sampling in 4.17, footnote f) to Table 3 and footnote i) to Table 4 shall be followed. For the active flammability test, the rules of sampling in 4.18 shall be followed. For RC units, the sample of highest capacitance values and the sample of the lowest capacitance values shall contain each, as nearly as possible, equal number of resistors of the highest and lowest resistance value in the range to be qualified. Where only one capacitance value is involved, the total number of capacitors as stated in Tables 3, 4 and 5 shall be tested.

Spare specimens are permitted as follows:

a) one per capacitance value which may be used to replace the permitted nonconforming item in Group 0;

b) the remainder of the spare specimens may be required, if it is necessary, to repeat any test according to the provisions of footnote a) of either Tables 3 or 4.

The numbers given in Group 0 assume that all subgroups are applicable. If this is not so, the numbers may be reduced accordingly.

When additional groups are introduced into the qualification approval test schedule, the number of specimens required for Group 0 shall be increased by the same number as that required for the additional groups.

Tables 3, 4 and 5 give the number of specimens to be tested in each group or subgroup together with the permissible number of nonconforming items in each case.

Where a range of ceramic capacitors to be qualified consists of different temperature coefficients or the range of capacitors employs significantly different materials, the samples for Groups 2, 3 and 7 shall contain the specified quantity of specimens for each dielectric material.

3.4.3.2 Tests

One of the complete series of tests indicated in Tables 3, 4 or 5 is required for the approval of capacitors of a single rated voltage covered by one detail specification. The tests of each group shall be carried out in the order given.

The whole sample shall be subjected to the tests of Group 0 and then subdivided for the other groups.

A specimen found to be a nonconforming item during the tests of Group 0 shall not be used for the other groups.

"One nonconforming item " is counted when a capacitor has not satisfied the whole or part of the tests of a group.

Approval is granted when the number of nonconforming items does not exceed the specified number of permissible nonconforming items for each group and subgroup and the total number of permissible nonconforming items.

NOTE Tables 3 and 6 or 4, Tables 5 and 7 form the fixed sample size test schedule. Tables 3, 4 or 5 include the details for the sampling and permissible nonconforming items for the different tests or groups of tests. Tables 6 or 7, together with the details of test contained in Clause 4, give a complete summary of test conditions and performance requirements and indicate where, for test methods or conditions of test, a choice has to be made in the detail specification.

The conditions of test and performance requirements for the fixed sample size schedule should be identical to those prescribed in the detail specification for the quality conformance inspection.

Table 3 – Sampling plan – Tests concerning safety requirements only

Group	Test	Subclause of this specification	Number of specimens tested per rated voltage and subclass	Permitted number of nonconforming items per rated voltage and subclass	
				Per group	Total
0	Visual examination	4.1	28+12[d] +	1[b]	
	Capacitance	4.2.2	6[e] +		
	Resistance[c]	4.2.4	(6-18)[f]		
	Voltage proof	4.2.1	+24		
	Insulation resistance	4.2.5			
	Spares		14+6[e]		
1A	Creepage distances and clearances	4.1.1	6	0[a), b)]	1
	Robustness of terminations	4.3			
	Resistance to soldering heat[c]	4.4			
	Solvent resistance of the marking	4.20			
2	Damp heat, steady state	4.12	10	0[a), b)]	
3	Impulse voltage	4.13			
	Endurance	4.14			
	Class X and RC units	4.14.3	12[d]		
	Class Y and RC units	4.14.4	12[d]	0[a), b)]	
	Lead-through[g]	4.14.5	6[e]		
6	Passive flammability	4.17	6-18[f]	0	
7	Active flammability	4.18	24	0	

[a] If one nonconforming item is obtained, all the tests of the group shall be repeated on a new sample and then no further nonconforming items are permitted. The nonconforming items obtained in the first sample shall be counted for the total nonconforming items permitted in the last column.

[b] For Y-capacitors, no permanent short-circuit failures are permitted.

[c] If applicable.

[d] If multi-section capacitors consisting of X- and Y-capacitors are to be tested, 12 specimens shall be taken for the tests on the X-capacitors and 12 other specimens for the tests on the Y-capacitors.

[e] Additional capacitors if lead-through capacitors are tested.

[f] See footnote i) to Table 4.

[g] Attention is drawn to the option of carrying out a combined voltage/current test, as prescribed in 4.14.6.

Table 4 – Sampling plan – Safety and performance tests qualification approval – Assessment level D / DZ

Group	Test	Subclause of this specification	Number of specimens tested per rated voltage and subclass	Permitted number of nonconforming items per rated voltage and subclass			
				Per group		Total	
				D	DZ	D	DZ
0	Visual examination	4.1	50+12[e] +	1[b]	0[a]		
	Dimensions (gauging)	4.1	6[f] +				
	Capacitance	4.2.2	(6-18)[i]				
	Resistance[c]	4.2.4	+24				
	Tangent of loss angle[h]	4.2.3					
	Voltage proof	4.2.1					
	Insulation resistance	4.2.5					
	Spares		20				
1A	Dimensions (detail)	4.1	6	0[a]	0[a]	2	0
	Robustness of terminations	4.3					
	Resistance to soldering heat[c]	4.4					
	Component solvent resistance[c]	4.19					
1B	Solderability[c]	4.5	12	0[a]	0[a]		
	Solvent resistance of the marking	4.20					
	Rapid change of temperature	4.6					
	Vibration	4.7					
	Bump or shock[g]	4.8 or 4.9					
1	Container sealing[c], [d]	4.10	18	1[b]	0[b]		
	Climatic sequence	4.11					
2	Damp heat, steady state	4.12	10	0[a], [b]	0[a], [b]		
3	Impulse voltage	4.13					
	Endurance	4.14					
	Class X and RC units	4.14.3	12[e]	0[a], [b]	0[a], [b]		
	Class Y and RC units	4.14.4	12[e]				
	Lead-through[j]	4.14.5	6[f]				
4	Charge and discharge[c]	4.15	6	0[a]	0[a]		
5	Radiofrequency characteristics[d]	4.16	4	1	0[a]		
6	Passive flammability	4.17	(6-18)[i]	0	0		
7	Active flammability	4.18	24	0	0		

[a] If one nonconforming item is obtained, all the tests of the group shall be repeated on a new sample and then no further nonconforming items are permitted. The nonconforming item obtained in the first sample shall be counted for the total nonconforming items permitted in the last column.

[b] For Y-capacitors, no permanent short-circuit failures are permitted.

[c] If applicable.

[d] If required in the detail specification.

[e] If multi-section capacitors consisting of X- and Y-capacitors are to be tested, 12 specimens shall be taken for the tests on the X-capacitors and 12 other specimens for the tests on the Y-capacitors.

[f] Additional capacitors if lead-through capacitors are tested.

[g] Whichever is prescribed by the detail specification.

[h] Not required for RC units, or for capacitors other than those of metallized film or metallized paper construction.

[i] The smallest, a medium (in the case of more than four case sizes) and the largest case size shall be tested. Of each case size, three specimens of the maximum capacitance and three specimens of the minimum capacitance shall be tested, resulting in six specimens per case size.

[j] Attention is drawn to the option of carrying out a combined voltage/current test as prescribed in 4.14.6.

Table 5 – Test schedule and sampling plan for lot-by-lot tests

Safety tests only			
Group	**Clause number and test referred to Clause 4 of this specification**	**Inspection level IL**	**Acceptance number**
A0	4.2.2 Capacitance 4.2.4 Resistance [a)] 4.2.1 Voltage proof [d)]	100 % [b)]	
A1	4.1 Visual examination Dimensions [c)]	S-4	0
	4.2.5 Insulation resistance (Test A)	I	0

[a)] If applicable.
[b)] May be carried out as end-of-line testing.
[c)] This test may be replaced by in-production testing if the manufacturer installs SPC on dimensional measurements or other mechanisms to avoid parts exceeding limits.
[d)] The voltage proof test shall be combined with a suitable monitoring method to detect defects in insulation resistance.

Qualification approval – Assessment level D			
Group	**Clause number and test referred to Clause 4 of this specification**	**Inspection level IL**	**Acceptable quality level AQL %**
A1	4.1 Visual examination 4.1 Dimensions (gauging)	II	1,5
A2	4.2.2 Capacitance 4.2.4 Resistance [a)] 4.2.3 Tangent of loss angle (metallized and ceramic capacitors only) 4.2.1 Voltage proof (Test A) 4.2.5 Insulation resistance (Test A)	II	0,25
B1	4.5 Solderability [a)]	S-3	2,5

[a)] If applicable.

Qualification approval – Assessment level DZ			
Group	**Clause number and test referred to Clause 4 of this specification**	**Inspection level IL**	**Acceptance number [b)]**
A1	4.1 Visual examination 4.1 Dimensions (gauging)	S-4	0
A2	4.2.2 Capacitance 4.2.4 Resistance [a)] 4.2.3 Tangent of loss angle (metallized and ceramic capacitors only) 4.2.1 Voltage proof (Test A) 4.2.5 Insulation resistance (Test A)	I	0
B1	4.5 Solderability [a)]	S-3	0

[a)] If applicable.

[b)] If one nonconforming item is obtained, all the tests of the group shall be repeated on a new sample, and then no further nonconforming items are permitted.

Table 6 – Test schedule for safety tests only

Subclause number and test [a]	Conditions of test [a]	n and c [b]	Performance requirements [a]
Group 0	**Non-destructive**	See Table 3	
4.1 Visual examination			No visible damage Legible marking
4.2.2 Capacitance			Within specified tolerance
4.2.4 Resistance (if applicable)			Within specified tolerance
4.2.1 Voltage proof	Method: ...		No permanent break-down or flashover
4.2.5 Insulation resistance	Method: ...		As in Table 11
Group 1A	**Destructive**	See Table 3	
4.1.1 Creepage distances and clearances			As 4.1.1
4.3 Robustness of terminations	Severity: see detail specification		No visible damage
4.4 Resistance to soldering heat (if applicable)	No pre-drying See detail specification for the Method (1A or 1B)		
4.20 Solvent resistance of the marking			Legible marking
4.4.2 Final measurements	Visual examination		No visible damage
	Capacitance		See Table 13
	Resistance (if applicable)		See Table 13
Group 2	**Destructive**	See Table 3	
4.12 Damp heat, steady state			
4.12.1 Initial measurements	Group 0 measurements to be used		
4.12.2 Test conditions	Ceramic capacitors: half of the sample with U_R applied; the other half with no voltage applied		
	Other capacitors: no voltage applied		
4.12.3 Final inspection and measurements	Visual examination		No visible damage Legible marking
	Capacitance		See Table 15
	Resistance (if applicable)		See Table 15
	Voltage proof		See Table 15
	Insulation resistance		See Table 15

Table 6 *(continued)*

Subclause number and test [a]	Conditions of test [a]	*n* and *c* [b]	Performance requirements [a]
Group 3	**Destructive**	See Table 3	
4.13.1 Initial measurements	Group 0 measurements to be used		
4.13 Impulse voltage	3 pulses, full wave		See 4.13.2 and 4.13.3
	Peak voltage: see Table 1 and Table 2		
4.14 Endurance	Duration: 1 000 h		
	Voltage, current and temperature: see 4.14.3, 4.14.4, 4.14.5 and 4.14.6		
4.14.7 Final measurements	Visual examination		No visible damage Legible marking
	Capacitance		See Table 16
	Resistance (if applicable)		See Table 16
	Voltage proof		See Table 16
	Insulation resistance		See Table 16
Group 6	**Destructive**	See Table 3	
4.17 Passive flammability			See 4.17.1
Group 7	**Destructive**	See Table 3	
4.18 Active flammability			See 4.18.4

[a] Subclause numbers of test conditions and requirements refer to Clause 4.

[b] *n* = number of specimens, *c* = number of permissible nonconforming items.

[c] When, for a ceramic capacitor, a precise measurement of capacitance drift is required, preconditioning according to Annex G should be performed as advised by the manufacturer.

Table 7 – Test schedule for safety and performance tests qualification approval – Assessment level D / DZ

Subclause number and test [a]		Conditions of test [a]	*n* and *c* [b]	Performance requirements [a]
Group 0		**Non-destructive**	See Table 4	
4.1	Visual examination			No visible damage Legible marking and as specified in the detail specification
4.1	Dimensions (gauging)			See detail specification
4.2.2	Capacitance			Within specified tolerance
4.2.4	Resistance (if applicable)			Within specified tolerance
4.2.3	Tangent of loss angle (metallized and ceramic capacitors only)	Frequency: ...		See detail specification
4.2.1	Voltage proof	Method: ...		No permanent break-down or flashover
4.2.5	Insulation resistance	Method: ...		See Table 12
Group 1A		**Destructive**	See Table 4	
4.1	Dimensions (detail)			See detail specification and Table 9
4.3	Robustness of terminations	Severity: see detail specification		No visible damage
4.4	Resistance to soldering heat (if applicable)	No pre-drying See detail specification for the Method (1A or 1B)		
4.19	Component solvent resistance (if applicable)	Solvent: ... Solvent temperature: ... Method 2 Recovery: ...		See detail specification
4.4.2	Final measurements	Visual examination		No visible damage
		Capacitance		See Table 13
		Resistance (if applicable)		See Table 13

Table 7 *(continued)*

Subclause number and test [a]	Conditions of test [a]	n and c [b]	Performance requirements [a]
Group 1B	**Destructive**	See Table 4	
4.5 Solderability (if applicable)	Without ageing For method see detail specification		Good tinning as evidenced by free flowing of the solder with wetting of the terminations or solder shall flow within 3 s, as applicable.
4.20 Solvent resistance of the marking	Solvent: ... Solvent temperature: ... Method 1 Rubbing material: cotton wool Recovery: ...		Legible marking
4.6 Rapid change of temperature	T_A = Lower category temperature T_B = Upper category temperature Five cycles Duration t_1 = 30 min		
4.6.1 Final inspection	Visual examination		No visible damage
4.7 Vibration	For mounting method and severity: see detail specification		
4.7.2 Final inspection	Visual examination		No visible damage
4.8 or 4.9 Bump or Shock	For mounting method and severity: see detail specification		
4.8.2 or 4.9.2 Final measurements	Visual examination Capacitance Resistance (if applicable)		No visible damage See 4.8.2 or 4.9.2 of this specification See Table 14
Group 1	**Destructive**	See Table 4	
4.10 Container sealing (if applicable)	Test Qc or Test Qd of IEC 60068-2-17 as prescribed in the detail specification		No evidence of leakage
4.11 Climatic sequence	Measurements made in 4.4.2, 4.8.2 or 4.9.2 as appropriate		
4.11.1 Initial measurements	Temperature: upper category temperature		
4.11.2 Dry heat	Duration: 16 h		
4.11.3 Damp heat, cyclic, test Db, first cycle			
4.11.4 Cold	Temperature: lower category temperature Duration: 2 h		
4.11.5 Damp heat, cyclic, test Db, remaining cycles			
4.11.6 Final measurements	Visual examination Capacitance Resistance (if applicable) Tan δ (if applicable) Voltage proof Insulation resistance		No visible damage Legible marking See Table 14 See Table 14 See Table 14 See Table 14 See Table 14

Table 7 *(continued)*

Subclause number and test [a]	Conditions of test [a]	n and c [b]	Performance requirements [a]
Group 2	**Destructive**	See Table 4	
4.12 Damp heat, steady state			
4.12.1 Initial measurements	Group 0 measurements to be used		
4.12.2 Test conditions	Ceramic capacitors: half of the sample with U_R applied; the other half with no voltage applied		
	Other capacitors: no voltage applied		
4.12.3 Final measurements	Visual examination		No visible damage Legible marking
	Capacitance		See Table 15
	Resistance (if applicable)		See Table 15
	Tan δ (if applicable)		See Table 15
	Voltage proof		See Table 15
	Insulation resistance		See Table 15
Group 3	**Destructive**	See Table 4	
4.13.1 Initial measurements	Group 0 measurements to be used		
4.13 Impulse voltage	Number of impulses: 24 max. Peak voltage: ... V; see Tables 1 and 2		See 4.13.2 and 4.13.3
4.14 Endurance	Duration: 1 000 h		
	Voltage, current and temperature: see 4.14.3, 4.14.4, 4.14.5 and 4.14.6		
4.14.7 Final measurements	Visual examination		No visible damage Legible marking
	Capacitance		See Table 16
	Resistance (if applicable)		See Table 16
	Tan δ (if applicable)		See Table 16
	Voltage proof		See Table 16
	Insulation resistance		See Table 16
Group 4	**Destructive**	See Table 4	
4.15 Charge and discharge	Only for metallized and ceramic capacitors and RC units using such capacitors		
4.15.1 Initial measurements	Group 0 measurements may be used, provided the measuring conditions are the same as required for this test; in addition, except for RC units, tan δ shall be measured at: 10 kHz for $C_R \leq 1$ µF 1 kHz for $C_R > 1$ µF		
4.15.3 Final measurements	Capacitance		See Table 17
	Tan δ at same frequency as initial measurement (not for RC units)		See Table 17
	Resistance (if applicable)		See Table 17
	Insulation resistance		See Table 17

Table 7 *(continued)*

Subclause number and test [a]	Conditions of test [a]	*n* and *c* [b]	Performance requirements [a]
Group 5 4.16 Radiofrequency characteristics	**Non-destructive** If required in the detail specification; see detail specification for measuring method	See Table 4	See detail specification
Group 6 4.17 Passive flammability	**Destructive**	See Table 4	See 4.17.1
Group 7 4.18 Active flammability	**Destructive**	See Table 4	See 4.18.4

[a] Subclause numbers of test conditions and requirements refer to Clause 4.

[b] *n* = number of specimens, *c* = number of permissible nonconforming items.

[c] When, for a ceramic capacitor, a precise measurement of capacitance drift is required, preconditioning according to Annex G should be performed as advised by the manufacturer.

3.5 Quality conformance inspection

Before submission to the quality conformance inspection an appropriate 100 % voltage proof test between terminations according to Table 10 shall be made.

The details of this test shall be the prerogative of the manufacturer, but the time shall be not less than 1 s.

If the test is performed in a time period between 1 s and 2 s the voltage of Table 10 shall be increased to values above curve B of Figure 6.

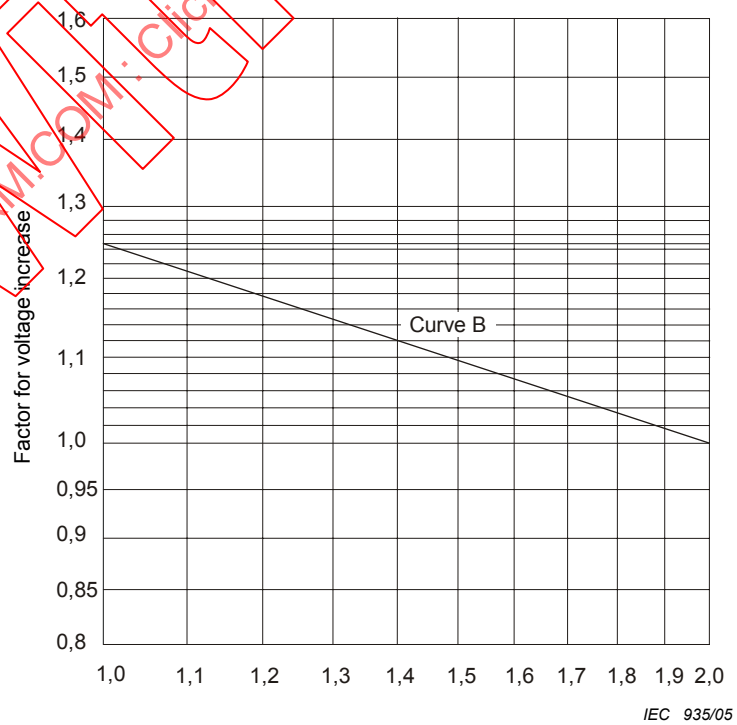

Figure 6 – Test duration (s)

If a d.c. test voltage is used instead of a.c. for Y-capacitors, it shall be not less than 1,5 times the a.c. test voltage in Table 10 and further increased to values above curve B of Figure 6.

All nonconforming items shall be removed from the lot prior to lot-by-lot testing.

3.5.1 Formation of inspection lots

3.5.1.1 Groups A and B inspection

These tests shall be carried out on a lot-by-lot basis according to Table 8.

A manufacturer may aggregate the current production into inspection lots subject to the following safeguards:

a) the inspection lot shall consist of structurally similar capacitors (see 3.2);

b1) the sample tested shall be representative of the values and dimensions contained in the inspection lot:

- in relation to their number;
- with a minimum of five of any one value;

b2) if there are less than five of any one value in the sample the basis for the drawing of samples shall be agreed between the manufacturer and the National Supervising Inspectorate.

For Group A tests, the inspection lot shall consist of components of the same rated voltage, class and subclass and shall be taken from one continuous production run.

No nonconforming items are permitted for Class Y-capacitors in the voltage proof test.

For Group B tests, the inspection lot shall consist of components produced with similar processes and materials, as related to the test concerned.

3.5.1.2 Group C inspection

Safety tests only approval

Re-qualification tests according to Table 6 may be required by the certification body when a change of the declared design as given in Annex D is intended.

The certification body shall be informed about the intended change(s) and decide whether re-qualification tests have to be performed.

Qualification approval

These tests shall be carried out on a periodic basis.

The samples to be submitted to the periodic test in Table 8 shall be representative of the current production of the specified periods and shall be taken from the same rated voltage, class and subclass. In subsequent periods, other case sizes in production shall be tested with the aim of covering the whole range of the approval.

No nonconforming items are permitted for Class Y capacitors in the voltage proof test.

3.5.2 Test schedule

Safety tests only approval

The schedule for the lot-by-lot tests or criteria for re-qualification are given in Table 5 and Annex D of this specification.

Qualification approval

The schedule for the lot-by-lot and periodic tests for quality conformance Inspection is given in Table 4 of Clause 2 of the blank detail specification, for example, IEC 60384-14-1.

3.5.3 Delayed delivery

Re-inspection in the case of delayed delivery shall be carried out at intervals not exceeding three years. When according to the procedures of IEC 60384-1, 3.10, re-inspection has to be made, voltage proof at the full relevant test voltage, capacitance, resistance (if applicable) and insulation resistance shall be checked as specified in Group A inspection and solderability shall be checked according to Group B inspection.

3.5.4 Assessment levels

The assessment level(s) given in the blank detail specification shall preferably be selected from Table 8.

Table 8 – Assessment levels

Inspection subgroup [b]	D		DZ	
	IL	*AQL* %	*IL*	Acceptance number
A1	II	1,5	S-4	0
A2	II	0,25	I	0
B1	S-3	2,5	S-3	0

Inspection subgroup [b]	D			DZ		
	p	*n*	*c*	*p*	*n*	*c* [a]
C1A	6	6	0	6	6	0
C1B [c]	6	12	0	6	12	0
C1	6	18	1	6	18	0
C2	6	10	0	6	10	0
C3						
Class X		12			12	
Class Y	3	12	0	3	12	0
Lead-through		6			6	
C4	6	6	1	6	6	0
C5	12	4	1	12	4	0
C6	12	6-18	0	12	6-18	0
C7	12	24	0	12	24	0

IL = inspection level

AQL = acceptable quality level

p = periodicity in months

n = sample size

c = permissible number of nonconforming items

[a] If one nonconforming item is obtained, all the tests of the group shall be repeated on a new sample and then no further nonconforming items are permitted.

[b] The content of the inspection subgroups is described in Clause 2 of the relevant blank detail specification.

[c] The vibration, bump and shock tests in this subgroup are required to be carried out every 12 months only.

4 Test and measurement procedures

This clause supplements the information given in Clause 4 of IEC 60384-1.

AC tests performed at 50 Hz can be considered valid up to 100 Hz.

4.1 Visual examination and check of dimensions

See 4.4 of IEC 60384-1 with the following additional details.

4.1.1 Creepage distances and clearances

Creepage distances and clearances on the outside of the capacitor between live parts of different polarity or between live parts and a metal case shall be not less than the appropriate values given in Table 9.

This table is extracted from the table in Clause 29 of IEC 60335-1. Further information may be obtained by reference to the full table.

Compliance shall be checked by measurement according to the rules laid down in IEC 60335-1 for measurements on the outside of the capacitor. Additional requirements may be necessary, for example for drip-proof and splashproof capacitors.

Table 9 – Creepage distances and clearances

Points of measurement	Rated voltage (r.m.s.)							
	$U_R \leq 130$ V		130 V < $U_R \leq 250$ V		250 V < $U_R \leq 500$ V		500 V < $U_R \leq 760$ V	
	Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance	Creepage distance	Clearance
	mm	mm	mm	mm	mm	mm	mm	mm
Between live parts of different polarity [a]	2,0	1,5	3,0	2,5	4,0	3,0	6,3	5,5
Between live parts and other metal parts over basic insulation [b]	2,0	1,5	4,0	3,0	6,3	5,5	6,3	5,5
Between live parts and other metal parts over reinforced insulation [c]	8,0	8,0	8,0	8,0	8,0	8,0	-	-

[a] These limits shall be used for measurements between terminals of an X-capacitor.

[b] These limits shall be used for measurements between either terminal and the metal case of an X-capacitor and for measurements between terminals or between either terminal and the metal case of a Y2-, Y3- or Y4-capacitor.

[c] These limits shall be used for measurements between the terminals of a Y1- capacitor.

4.2 Electrical tests

4.2.1 Voltage proof

See 4.6 of IEC 60384-1 with the following details.

4.2.1.1 Test circuit for d.c. tests

Omit the capacitor C_1 if the capacitor under test, or a section of it, is a metallized film or metallized paper capacitor.

The product of R_1 and (C_1 + C_X) shall be less than, or equal to, 1 s and greater than 0,01 s.

R_1 includes the internal resistance of the power supply.

R_2 shall limit the discharge current to a value equal to, or less than, 0,05 A.

4.2.1.2 Test circuit and method for a.c. tests

When for qualification approval and periodic tests a 50/60 Hz voltage is applied, the voltage shall be supplied from a transformer fed from a variable auto-transformer, and the voltage shall be raised from near zero to the test voltage at a rate not exceeding 150 V/s. The test time shall be counted from the time the test voltage is reached. At the end of the test time the test voltage shall be reduced to near zero and the capacitor discharged through a suitable resistor.

For lot-by-lot and 100 % testing, the voltage shall be applied directly at the full test voltage, but care should be taken to avoid overvoltage peaks.

4.2.1.3 Applied voltage

The voltages of Table 10 shall be applied between the respective measuring points shown in Table 3 of IEC 60384-1 for a period of 1 min for qualification approval and periodic testing and for a period of not less than 1 s for lot-by-lot quality conformance testing, with the following details:

a) the test according to 2C. of Table 3 of IEC 60384-1 shall not be carried out;

b) for encapsulated units with a non-metallic case, a voltage proof test such as Test C shall be carried out only for qualification approval tests and periodic tests;

c) the method of applying the test voltage for Test C shall be given in the detail specification. For qualification testing, the foil method given in 4.5.3.1 of IEC 60384-1 shall be used, unless otherwise specified in the detail specification;

d) for testing during a period between 1 s and 2 s, the voltage of Table 10 shall be increased as indicated in Figure 6.

Attention is drawn to the fact that repetition of the voltage proof test by the user may damage the capacitor.

Table 10 – Voltage proof

Class	Range of rated voltages	Test A	Test B or test C
X1 X2 X3	≤ 760 V	4,3 U_R (d.c.)	2 U_R + 1 500 V (a.c.) with a minimum of 2 000 V (a.c.) [a]
Y1	≤ 500 V	4 000 V (a.c.)	4 000 V (a.c.)
Y2	≥ 150 V ≤ 300 V	1 500 V (a.c.) [b]	2 U_R + 1 500 V (a.c.) with a minimum of 2 000 V (a.c.) [b]
Y3	≤ 250 V	1 500 V (a.c.) [b]	
Y4	< 150 V	900 V (a.c.) [b]	900 V (a.c.) [b]

[a]) For delta and T-connected capacitor units according to Figures 5b and 5c, the test voltage for terminals to case shall be the appropriate test voltage for the Y-capacitors.

[b]) For lot-by-lot tests of Class Y2-, Y3- and Y4-capacitors, the a.c. test voltage may be replaced by a d.c. voltage of 1,5 times the prescribed a.c. voltage.

4.2.1.4 Requirement

There shall be no permanent breakdown or flashover during the test period.

4.2.2 Capacitance

See 4.7 of IEC 60384-1 with the following details.

4.2.2.1 Measuring conditions

The capacitance measured shall be the series equivalent capacitance.

The measuring frequency shall be 1 kHz, but, only for ceramic capacitors with $C_R \leq 100$ pF, the measuring frequency shall be 1 MHz.

The measuring temperature shall be in accordance with 4.2.1 of IEC 60384-1.

The measuring voltage shall not exceed the rated voltage. For ceramic capacitors the measuring voltage shall be 1,0 V ± 0,2 V.

As the rated capacitance of ceramic capacitors, as measured above, is the small-signal capacitance, the manufacturer shall supply the following information for ceramic capacitors:

a) the maximum expected 50/60 Hz current through the capacitor at rated voltage taking into account capacitance tolerance and temperature characteristic of capacitance;

b) the minimum expected capacitance taking into account capacitance tolerance and temperature characteristic of capacitance.

4.2.2.2 Requirements

The capacitance value shall be within the specified tolerance.

4.2.3 Tangent of loss angle

This test is normally required for metallized and ceramic capacitors only.

See 4.8 of IEC 60384-1 with the following details:

The measuring frequency shall be 10 kHz for $C_R \leq 1$ µF and 1 kHz for $C_R > 1$ µF.

4.2.4 Resistance (Equivalent Series Resistance (ESR)) (for RC units only)

The ESR shall be measured in a series equivalent circuit at the following frequency:

100 kHz for $R_R \times C_R < 50$ µs;

1 kHz for $R_R \times C_R \geq 50$ µs.

where

R_R is the rated resistance in ohms, and

C_R is the rated capacitance in farads.

4.2.5 Insulation resistance

See 4.5 of IEC 60384-1 with the following details.

In lot-by-lot quality conformance testing the measuring may be interrupted at the time that the value of the insulation resistance exceeds the limits of Tables 11 or 12, which can be shorter than 60 s.

4.2.5.1 Temperature correction

When prescribed in the detail specification the temperature at which the measurement is made shall be noted. If this temperature differs from 20 °C, a correction shall be made to the measured value by multiplying it by the appropriate correction factor prescribed in the sectional specification for the relevant dielectric, or given in the detail specification.

4.2.5.2 Requirements

The insulation resistance shall exceed the values of Tables 11 or 12 as appropriate.

Table 11 – Insulation resistance – Safety tests only

Test A		Test B or Test C
When C_R > 0,33 µF RC in s	When C_R ≤ 0,33 µF R in MΩ	R in MΩ
2 000 [b)]	6 000	6 000
NOTE See Table 12.		

Table 12 – Insulation resistance – Safety and performance tests

Dielectric	Test A		Test B or Test C
	When C_R > 0,33 µF RC_R in s	When C_R ≤ 0,33 µF R in MΩ	R in MΩ
Paper [a), b)]	2 000	6 000	6 000
Plastic	5 000	15 000	30 000
Ceramic	–	6 000	3 000

[a)] Also for mixed plastic/paper dielectrics.

[b)] For capacitors with ester-impregnated paper dielectric, the values in the last three columns of the table shall be replaced respectively by the values 500, 1 500 and 2 000.

NOTE 1 In the tables above, C_R is the rated capacitance and R the measured insulation resistance.

NOTE 2 Limits more severe and related to the dielectric may be given in the detail specification for performance tests only, where possible by reference to the appropriate IEC Publication.

NOTE 3 For capacitors having one termination connected to the case, the insulation resistance limits for Test A should be used.

NOTE 4 For capacitors with a discharge resistor, measurement should be carried out with the discharge resistor disconnected. If the resistor cannot be disconnected without the capacitor being destroyed, the test should be omitted in Group A; and, for qualification approval and periodic tests, the test should be carried out on half of the specimens in the sample, which should consist of capacitors specially made without discharge resistors.

4.3 Robustness of terminations

See 4.13 of IEC 60384-1 with the following details.

The test method and degree of severity to be used shall be specified in the detail specification.

The test for snap-in contacts shall be specified in the detail specification; the test methods and severity shall comply with the applicable parts of IEC 60760.

4.4 Resistance to soldering heat

This test is not applicable to capacitors with insulated leads longer than 10 mm, or to capacitors with terminations not intended to be soldered (such as screw and fast-on terminations).

When, for fixed capacitors of ceramic dielectric Class 2, a precise measurement of capacitance drift is required, preconditioning should be performed as advised by the manufacturer (see Annex G).

See 4.14 of IEC 60384-1 with the following details.

4.4.1 Test conditions

There shall be no pre-drying.

4.4.2 Final inspection, measurements and requirements

The final measurements after this test are the intermediate measurements after the tests of Subgroup 1A and before the remainder of the tests of Group 1. The capacitors shall be visually examined and measured and shall meet the requirements of Table 13.

Table 13 – Resistance to soldering heat – Requirements

Inspection or measurement	Inspection or measuring method	Requirement
Visual examination	4.1	No visible damage
Capacitance	4.2.2	The difference between the capacitance measured finally and in Group 0 of Table 3, or Table 4 shall not exceed 5 % [a)]
Resistance (if applicable)	4.2.4	$\lvert \Delta R/R \rvert \leq 5$ %
[a)] For ceramic capacitors the capacitance difference shall not exceed 10 %.		

4.5 Solderability

This test is not applicable to capacitors with terminations not intended for soldering (such as screw terminations and snap-in contacts).

See 4.15 of IEC 60384-1, with the following details.

4.5.1 Test conditions

No ageing is required.

When Method 2 is used, a soldering iron of size A shall be used.

4.5.2 The requirements are given in Table 7.

4.6 Rapid change of temperature

When for fixed capacitors of ceramic dielectric, Class 2 a precise measurement of capacitance drift is required, preconditioning should be performed as advised by the manufacturer (see Annex G).

See 4.16 of IEC 60384-1 with the following details.

Number of cycles: 5.

Duration of exposure at the temperature limits: 30 min.

4.6.1 Final inspection

The capacitors shall be visually examined and there shall be no visible damage.

4.7 Vibration

See 4.17 of IEC 60384-1 with the following details.

4.7.1 Test conditions

The following degree of severity of test Fc applies: 0,75 mm displacement or 100 m/s^2, whichever is the lower amplitude, over one of the following frequency ranges: 10 Hz to 55 Hz, 10 Hz to 500 Hz, 10 Hz to 2 000 Hz. The total duration shall be 6 h.

The detail specification shall prescribe the frequency range and shall also prescribe the mounting method to be used. For capacitors with axial leads which are intended to be mounted by the leads, the distance between the body and the mounting point shall be 6 mm ± 1 mm.

4.7.2 Final inspection

The capacitors shall be visually examined and there shall be no visible damage.

4.8 Bump

The detail specification shall state whether the bump or the shock test applies.

See 4.18 of IEC 60384-1, with the following details.

4.8.1 Test conditions

The following are the preferred severities.

Total number of bumps: 1 000 or 4 000

Acceleration: 400 m/s^2

Pulse duration: 6 ms

The mounting method and the severity shall be specified in the detail specification.

4.8.2 Final inspection, measurements and requirements

The final measurements after this test are the intermediate measurements after the tests of Subgroup 1B and before the remainder of the tests of Group 1.

The capacitors shall be visually examined and measured and shall meet the following requirements.

- There shall be no visible damage.

  The change of capacitance compared with the value measured in Group 0 of Table 4 shall not exceed 5 % except for ceramic capacitors where it shall not exceed 10 %.

  The value of tan δ shall not exceed the limit prescribed in the detail specification.

  The change of resistance (if applicable) shall not exceed the limit in Table 14.

4.9 Shock

The detail specification shall state whether the bump or the shock test applies.

See 4.19 of IEC 60384-1, with the following details.

4.9.1 Test conditions

The following severities are preferred.

Pulse-shape: half-sine wave

Peak acceleration m/s²	Corresponding duration of the pulse ms
500	11
1 000	6

The mounting method, the severity and the number of shocks along each axis shall be specified in the detail specification.

4.9.2 Final inspection, measurements and requirements

The final measurements after this test are the intermediate measurements after the tests of Subgroup 1B and before the remainder of the tests of Group 1.

The capacitors shall be visually examined and measured and shall meet the following requirements.

- There shall be no visible damage.
- The change of capacitance compared with the value measured in Group 0 of Table 4 shall not exceed 5 % except for ceramic capacitors where it shall not exceed 10 %.
- The value of tan δ shall not exceed the limit prescribed in the detail specification.
- The change of resistance (if applicable) shall not exceed the limit in Table 14.

4.10 Container sealing

This test is applicable only if prescribed in the detail specification.

See 4.20 of IEC 60384-1 with the following details.

4.10.1 Test conditions

The capacitors shall be subjected to either Test Qc or to Test Qd of IEC 60068-2-17, as appropriate. Unless otherwise specified in the detail specification, Method 1 shall be used when Test Qc is employed.

4.10.2 Requirements

During or after the test, as applicable, there shall be no evidence of leakage.

4.11 Climatic sequence

When, for fixed capacitors of ceramic dielectric Class 2, a precise measurement of capacitance drift is required, preconditioning should be performed as advised by the manufacturer (see Annex G).

See 4.2.1 of IEC 60384-1 with the following details.

4.11.1 Initial measurements

The initial measurements for the climatic sequence are the measurements made in 4.4.2, 4.8.2 or 4.9.2 as appropriate.

4.11.2 Dry heat

See 4.21.2 of IEC 60384-1 with the following details.

No measurements are required at the upper category temperature.

4.11.3 Damp heat, cyclic, test Db, first cycle

See 4.21.3 of IEC 60384-1.

4.11.4 Cold

See 4.21.4 of IEC 60384-1 with the following details.

No measurements are required at the lower category temperature.

4.11.5 Damp heat, cyclic, test Db, remaining cycles

See 4.21.6 of IEC 60384-1.

4.11.6 Final inspection, measurements and requirements

See 4.21.7 of IEC 60384-1, with the following details.

Recovery shall be for 24 h ± 2 h under standard atmospheric conditions for testing.

After recovery, the capacitors shall be visually examined and measured and shall meet the requirements of Table 14.

Table 14 – Climatic sequence – Requirements

Inspection or measurement	Inspection or measuring method	Requirement
Visual examination	4.1	No visible damage The marking shall be legible
Capacitance	4.2.2	The final capacitance value shall be within 5 %[a)] of the value measured in 4.4.2, 4.8.2 or 4.9.2 as applicable
Tangent of loss angle (metallized capacitors only)	4.2.3	The increase of tan δ over the value measured in Group 0 shall not exceed 0,008 for $C_R \leq 1$ µF 0,005 for $C_R > 1$ µF
Resistance (if applicable)	4.2.4	$\left\|\frac{\Delta R}{R}\right\| \leq 5\ \%$
Voltage proof	4.2.1	Test voltage as in Table 10 No permanent breakdown or flashover is permitted
Insulation resistance	4.2.5	Greater than 50 % of the applicable limits of Tables 11 or 12
[a)] For ceramic capacitors the capacitance difference shall not exceed 10 %.		

4.12 Damp heat, steady state

When, for fixed capacitors of ceramic dielectric Class 2, a precise measurement of capacitance drift is required, preconditioning should be performed as advised by the manufacturer (see Annex G).

See 4.22 of IEC 60384-1, with the following details.

4.12.1 Initial measurements

Initial measurements have been made in Group 0 of Tables 3 or 4.

4.12.2 Test conditions

When the test is made on ceramic capacitors, half of the sample shall have the rated voltage applied and the other half shall have no voltage applied.

For all other capacitors, no voltage shall be applied during the test.

4.12.3 Final inspection, measurements and requirements

Recovery shall be for 1 h to 2 h under standard atmospheric conditions for testing.

After recovery the capacitors shall be visually examined and measured and shall meet the requirements of Table 15.

Table 15 – Damp heat, steady state – Requirements

Inspection or measurement	Inspection or measuring method	Requirement
Visual examination	4.1	No visible damage The marking shall be legible
Capacitance	4.2.2	The final capacitance value shall be within 5 %[a)] of the value measured in Group 0 of Tables 3 or 4 as applicable
Tangent of loss angle (metallized capacitors only)	4.2.3	The increase of tan δ over the value measured in Group 0 shall not exceed 0,008 for $C_R \leq 1$ µF 0,005 for $C_R > 1$ µF
Resistance (if applicable)	4.2.4	$\left\|\frac{\Delta R}{R}\right\| \leq 5\ \%$
Voltage proof	4.2.1	Test voltage as in Table 10 No permanent breakdown or flashover is permitted
Insulation resistance	4.2.5	Greater than 50 % of the applicable limits of Tables 11 or 12

[a)] For ceramic capacitors the capacitance difference shall not exceed 15 %.

4.13 Impulse voltage

This test is to be carried out as a sequence with the endurance test described in 4.14.

4.13.1 Initial measurements

Initial measurements have been made in Group 0 of Table 3 or Table 4.

4.13.2 Test conditions

Capacitors except for those of subclasses X3 and Y3, shall be submitted to an impulse voltage test.

Each individual capacitor shall be subjected to a maximum of 24 impulses of the same polarity. The time between impulses shall be not less than 10 s. The peak value of the voltage impulse shall be as given in Table 1 and Table 2.

The rise time, $t_{r,}$ is defined as $t_r = (t_{90} - t_{30}) \times 1{,}67$ according to 18.1.4 of IEC 60060-1.

For the definition of the decay time t_d see 18.1.6 of IEC 60060-1.

The waveform will be determined by the test circuit parameters. Details of the test circuit are given in Annex A.

Before use, the functioning of the circuit shall be checked using C_X values of 0,01 μF and 0,1 μF and the values for the other circuit elements as given in Table A.1. The rise time t_r and decay time t_d shall be within 0 % + 50 % of the values given in Table A.2. The capacitors C_X used for this check should not be high-permittivity ceramic.

If the waveform from the check shows a damped oscillation, the peak-to-peak value of this oscillation, Upp, shall be not greater than 10 % of the peak voltage of the impulse U_{CR} (see Figure 7).

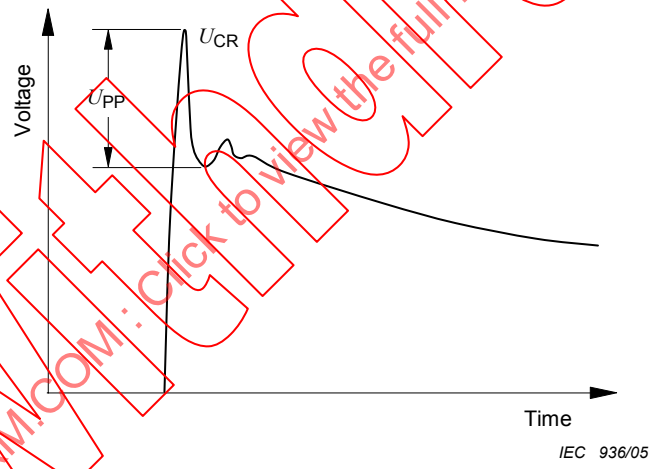

Figure 7 – Impulse wave form

4.13.3 Requirements

There shall be no permanent breakdown or flashover.

If any three successive impulses are shown by the oscilloscope monitor to have had a waveform indicating that no self-healing breakdowns or flashovers have taken place in the capacitor, then no further impulses shall be applied and the capacitor shall be counted as conforming.

If all 24 impulses have been applied to the capacitor and 3 or more of them are of a waveform indicating that no self-healing breakdowns or flashovers have occurred, then the capacitor shall be counted as conforming, but, if less than three impulses are of the required waveform, then the capacitor shall be counted as a nonconforming item.

4.14 Endurance

When, for fixed capacitors of ceramic dielectric Class 2, a precise measurement of capacitance drift is required, preconditioning should be performed as advised by the manufacturer (see Annex G).

The endurance test shall be started within one week of the completion of the impulse voltage test. See 4.23 of IEC 60384-1 with the following details.

4.14.1 Test conditions

The capacitors shall be placed in the test chamber in such a manner that no capacitor is within 25 mm of any other capacitor.

As an exception, when the width or diameter of the capacitor is less than 25 mm, then the distance between the capacitors may be reduced to the value of this width or diameter, provided that this causes no extra heating of the capacitors. In case of doubt, the 25 mm spacing shall be used.

The capacitors shall not be heated by direct radiation and the circulation of the air in the chamber shall be adequate to prevent the temperature from exceeding ±3 °C of the specified temperature at any point where capacitors are placed.

NOTE A fuse or other device of suitable sensitivity may be connected in the circuit of each capacitor to indicate if failure occurs.

Sampling

The sample for the endurance test shall be divided if necessary into two or three parts according to the numbers given in Tables 3, 4 or 5, so that separate tests may be carried out on the X-capacitors, the Y-capacitors and the lead-through arrangements.

For example, when testing delta capacitor units (see 1.5.9), 12 capacitor units shall be tested according to 4.14.3 and another 12 units according to 4.14.4. When testing a Class Y lead-through capacitor (see 1.5.8) 12 capacitors shall be tested according to 4.14.4 and 6 units according to 4.14.5.

4.14.2 Initial measurements

Initial measurements have been made in 4.13.1.

4.14.3 Endurance for Class X capacitors and RC units containing Class X capacitors

For multi-section capacitors, all X-sections shall be tested in parallel, if necessary, by shorting out any Y-sections. For T-connected capacitors (see 1.5.9), the test shall be carried out between the terminals normally connected to line and neutral.

The capacitors shall be submitted to an endurance test of 1 000 h at upper category temperature at a voltage of 1,25 U_R except that once every hour the voltage shall be increased to 1 000 V r.m.s. for 0,1 s. Each of these voltages shall be applied to each capacitor individually through a resistor of 47 Ω ± 5 %. The suitable circuit is shown in Annex B.

NOTE The value of this resistor is chosen to simulate the high-frequency impedance of the supply mains.

The test circuit should be designed so that voltage transients and current surges are avoided during switching. This may be achieved by discharging the capacitor before switching to the new voltage provided that the total time taken to change over to 1 000 V rms and back does not exceed 30 s.

4.14.4 Endurance for Class Y capacitors and RC units containing Class Y capacitors

For multi-section capacitors, all Y-sections shall be tested in parallel, if necessary, by shorting out any X-sections. For T-connected capacitors (see 1.5.9) the terminals normally connected to line and neutral shall be shorted and the test shall be carried out between them and the terminal normally connected to earth.

The capacitors shall be submitted to an endurance test of 1 000 h at upper category temperature at a voltage of 1,7 U_R, except that once every hour the voltage shall be increased to 1 000 V r.m.s. for 0,1 s. Each of these voltages shall be applied to each capacitor individually through a resistor of 47 Ω ± 5 %. The test circuit is shown in Annex B.

The test circuit should be designed so that voltage transients and current surges are avoided during switching. This may be achieved by discharging the capacitor before switching to the new voltage provided that the total time taken to change over the 1 000 V r.m.s. and back does not exceed 30 s.

4.14.5 Endurance for the lead-through arrangements

In addition to the endurance tests of the capacitors according to 4.14.3 and 4.14.4, the current-carrying capacity of the lead-through arrangements shall be tested. All the lead-through wires shall be connected in series and the capacitors submitted to an endurance test of 1 000 h with a current of 1,1 I_R passing through the lead-through wires. During this test, no voltage is applied to the capacitor dielectric.

The capacitors shall be mounted in the manner specified by the manufacturer, and the oven shall be stabilized at the rated temperature without current passing through the capacitors. The current shall then be switched on and the time counted from this moment.

After thermal stability has been re-established, the case temperature of one of the capacitors shall be measured. It shall not exceed the upper category temperature.

4.14.6 Test conditions – Combined voltage/current tests

For some types of capacitor, such as coaxial lead-through capacitors, it is possible without difficulty to apply both test voltage and current to the capacitor at the same time. If prescribed in the detail specification, a combined endurance test of 1 000 h may be carried out instead of the tests of 4.14.3 (or 4.14.4) and 4.14.5 using the number of specimens appropriate for the test of 4.14.3 (or 4.14.4) and 1,1 times the rated current flowing through the lead-through arrangements.

The case temperature of one of the capacitors shall be measured as in 4.14.5. It shall not exceed the upper category temperature.

4.14.7 Final inspection, measurements and requirements

The capacitors shall be visually examined and measured in the order given in Table 16.

Table 16 – Endurance – Requirements

Inspection or measurement	Inspection or measuring method	Requirement
Visual examination	4.1	No visible damage
Capacitance	4.2.2	The final capacitance value shall be within 10 % [a] of the value in Group 0 of Tables 3 or 4 as applicable
Tangent of loss angle (metallized capacitors only)	4.2.3	The increase of tan δ over the value measured in Group 0 shall not exceed 0,008 for $C_R \leq 1$ µF 0,005 for $C_R > 1$ µF
Resistance (if applicable)	4.2.4	$\lvert \Delta R / R \rvert \leq 10$ %
Voltage proof	4.2.1	Test voltage as in Table 10 No permanent breakdown or flashover is permitted
Insulation resistance	4.2.5	Greater than 50 % of the applicable limits of Tables 11 or 12
[a] For ceramic capacitors the capacitance difference shall not exceed 20 %.		

4.15 Charge and discharge

This test is applicable only to metallized capacitors, ceramic capacitors and RC units using such capacitors.

See 4.27 of IEC 60384-1 with the following details.

4.15.1 Initial measurements

Initial measurements have been made in Group 0 of Tables 3 or 4. In addition, except for RC units, tan δ shall be measured according to 4.8 of IEC 60384-1 with the following details.

C_R:	≤ 1 µF	C_R:	> 1 µF
Frequency:	10 kHz	Frequency:	1 kHz
Voltage:	1 V r.m.s. max.	Peak voltage:	≤ 3 % of rated voltage

4.15.2 Test conditions

The capacitors shall be subjected to 10 000 cycles of charge and discharge at the rate of approximately one operation per second.

Each cycle shall consist of charging and discharging the capacitor. For a.c. rated capacitors, the test voltage shall be $\sqrt{2} \times U_R$ and for d.c. capacitors the test voltage shall be U_R.

Each capacitor shall be individually charged by applying the test voltage through a resistor with the value

$$R = \frac{220 \times 10^{-6}}{C_R}\ \Omega$$

or the value required to limit the charge current to 1 A (or to the higher current value given in the detail specification) whichever resistance value is the greater.

Each capacitor shall be individually discharged through a resistor of such a value that the maximum rate of change of voltage (dU/dt) shall be approximately 100 V/μs.

For RC units, if it is impossible to achieve a discharge rate of 100 V/μs, the RC unit shall be discharged through a short circuit.

The circuit is given in Annex C.

4.15.3 Final measurements and requirements

The capacitor shall be measured and shall meet the requirements of Table 17.

Table 17 – Charge and discharge – Requirements

Inspection or measurement	Inspection or measuring method	Requirement
Capacitance	4.2.2	The final capacitance value shall be within 10 % [a] of the value in Group 0 of Tables 3 or 4 as applicable
Tan δ for $C_R \leq 1$ μF f = 10 kHz (if applicable)	4.15.1	The increase of tan δ over the value measured in 4.15.1 shall not exceed 80×10^{-4}
Tan δ for $C_R > 1$ μF f = 1 kHz (if applicable)	4.15.1	The increase of tan δ over the value measured in 4.15.1 shall not exceed 50×10^{-4}
Resistance (if applicable)	4.2.4	$\lvert\Delta R / R\rvert \leq 10$ %
Insulation resistance	4.2.5	Greater than 50 % of the applicable limits of Tables 11 or 12
[a] For ceramic capacitors, the capacitance difference shall not exceed 20 %.		

4.16 Radiofrequency characteristics

The detail specification may prescribe measuring methods and requirements for one or more of the following radiofrequency characteristics:

– the main resonant frequency of the capacitor;
– insertion loss (the methods of CISPR 17 shall be used where possible);
– resistance at resonant frequency;
– impedance of the capacitor;
– inductance of the capacitor.

4.17 Passive flammability test

See 4.38 of IEC 60384-1, with the following details.

No preconditioning is required.

The test shall be carried out on 6 to 18 specimens, depending on the number of case sizes tested. The smallest, a medium (in the case of more than 4 case sizes in the range to be qualified), and the largest case size in the range to be qualified, shall be tested. For each case size, 3 specimens, each of the highest and lowest capacitance values of the range to be qualified, shall be tested.

The flame shall be applied for the period of time specified in the generic specification corresponding to the volume of the specimen and the category of flammability specified in the detail specification.

If there is no requirement in a detail specification or other relevant specification, the test shall be carried out as for category C.

NOTE Passive flammability categories better than C may require flame retardant additives which may cause environmental impact. These categories should be subject to discussion between manufacturers and customers.

4.17.1 Requirements

The burning time specified in the generic specification shall not be exceeded by any specimen. The tissue paper shall not ignite. No electrical measurements are required.

4.18 Active flammability test

4.18.1 This test is not applicable to Y1 capacitors.

4.18.2 The sample of 24 specimens shall contain equal numbers of specimen of the highest, the lowest and an intermediate capacitance value in the range to be qualified. Where there are only two capacitance values in the range, 12 of each value shall be tested; where only 1 capacitance value is involved, 24 capacitors of this value shall be tested.

The specimens shall be individually wrapped in at least 1, but not more than 2, complete layers of cheesecloth. The cheesecloth shall be untreated pure cotton cloth with a mass of 20 g/m^2 to 60 g/m^2 and having a count of between 22 × 27 and 45 × 34 which has been pre-conditioned under standard atmospheric conditions for testing for 24 h.

Each test capacitor shall be mounted by its leads. The free length of the leads shall preferably be at least 25 mm.

Using the test circuit of Figure 8 with the following details:

U~ = U_R ± 5 %

U_i = 5 kV $^{+7}_{0}$ % for capacitors of Class Y2

= 4 kV $^{+7}_{0}$ % for capacitors of Class X1

= 2,5 kV $^{+7}_{0}$ % for capacitors of Class X2, Y3, Y4

= 1,2 kV $^{+7}_{0}$ % for capacitance of Class X3

each sample shall be subjected to 20 discharges from a tank capacitor, charged to a voltage that, when discharged, places U_i across the capacitor under test. The interval between successive discharges shall be 5 $^{+1}_{0}$ s.

Throughout the test, the U~ shall be applied across the capacitor under test and shall be maintained for 120 $^{+10}_{0}$ s after the last discharge, unless a blown fuse causes an open circuit.

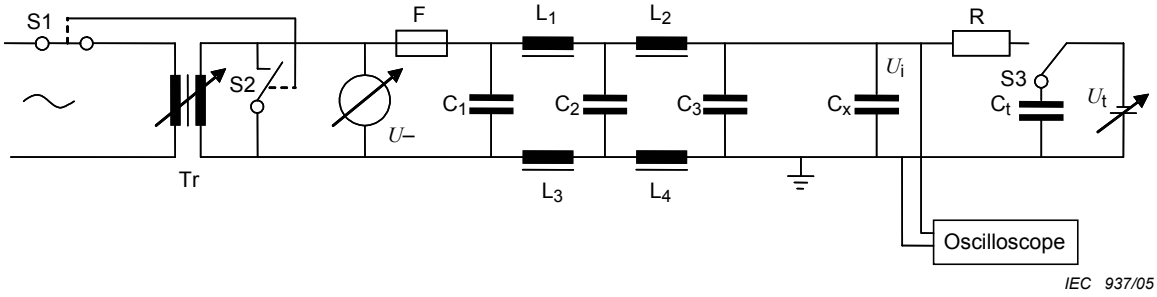

Figure 8 – Typical circuit for pulse loading of capacitors under a.c. voltage

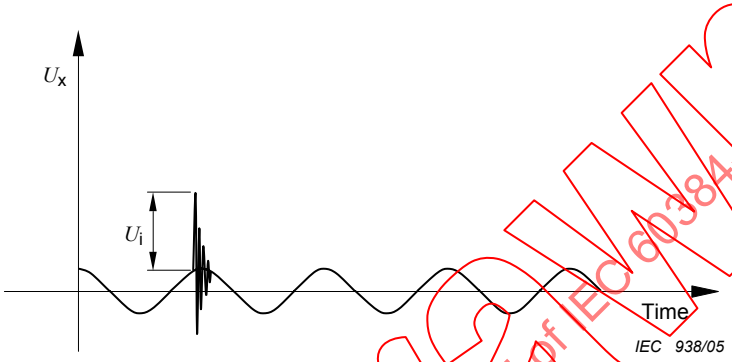

Figure 9 – Fundamental a.c. wave with randomly, not synchronized, superimposed high-voltage pulse

T_r = isolation transformer for blocking with secondary voltage of U~, and a sufficient capacity to supply 16 A to the test circuit at a voltage of ≥ 0,9 × U~;

C_1, C_2 = filter capacitor 1 µF ± 10 %;

L_1 .. L_4 = rod core choke 1,5 mH ± 20 %, 16 A;

C_3 = capacitor 0,033 µF ± 5 %;

R = 5 Ω ± 2 % for C_x ≥ 1 µF;

= 10 Ω ± 2 % for 0,22 µF ≤ C_x < 1 µF;

= 40 Ω ± 2 % for 0,068 µF ≤ C_x < 0,22 µF;

= 100 Ω ± 2 % for C_x < 0,068 µF;

C_X = capacitor under test;

U_t = voltage to which the tank capacitor C_t is charged;

C_t = tank capacitor 3 µF ± 5 %;

F = slow-blow fuse, rated 16 A.

NOTE 1 C_1, C_2 and L_1 .. L_4 comprise a mains protection filter; other configurations for these filters are permitted.

NOTE 2 C_3 and C_t should have a suitable voltage compared to the required U_t during test.

4.18.3 Adjustment of U_i

The a.c. voltage shall be switched off by S_1 and the secondary winding of the transformer shall be short-circuited by S_2. A set-up capacitor of capacitance C_x ± 5 % shall be connected in the C_x position. U_t shall then be adjusted so that the required peak voltage U_i appears across capacitor C_x, as demonstrated by the oscilloscope. The test shall then be conducted on the capacitors under test using this setting of U_t.

4.18.4 Requirements

The cheesecloth around the capacitor shall not burn with a flame. No electrical measurements are required.

4.19 Component solvent resistance (if applicable)

See 4.31 of IEC 60384-1.

The detail specification shall specify whether tests are required using solvents additional to those specified in the generic specification.

4.19.1 Requirements

The requirements shall be specified in the detail specification.

4.20 Solvent resistance of the marking

See 4.32 of IEC 60384-1.

The detail specification shall specify whether tests are required using solvents additional to those specified in the generic specification.

4.20.1 Requirements

The marking shall be legible.