

Fixed capacitors for use in electronic equipment —

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

The European Standard EN 60384-14:2005 has the status of a
British Standard

ICS 31.060.10

National foreword

This British Standard is the official English language version of EN 60384-14:2005. It is identical with IEC 60384-14:2005. It supersedes BS EN 132400:1995 which will be withdrawn on 1 July 2008.

The UK participation in its preparation was entrusted to Technical Committee EPL/40X, Capacitors and resistors for electronic equipment, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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

Cross-references

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 57 and a back cover.

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Amendments issued since publication

Amd. No.	Date	Comments

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 21 February 2006

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EUROPEAN STANDARD

EN 60384-14

NORME EUROPÉENNE

EUROPÄISCHE NORM

August 2005

ICS 31.060.10

Supersedes EN 132400:1994 + A2:1998 + A3:1998 + A4:2001

English version

**Fixed capacitors for use in electronic equipment
Part 14: Sectional specification –
Fixed capacitors for electromagnetic interference suppression
and connection to the supply mains
(IEC 60384-14:2005)**

Condensateurs fixes utilisés
dans les équipements électroniques
Partie 14: Spécification intermédiaire -
Condensateurs fixes d'antiparasitage
et raccordement à l'alimentation
(CEI 60384-14:2005)

Festkondensatoren zur Verwendung
in Geräten der Elektronik
Teil 14: Rahmenspezifikation -
Festkondensatoren zur Unterdrückung
elektromagnetischer Störungen,
geeignet für Netzbetrieb
(IEC 60384-14:2005)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 40/1552/FDIS, future edition 3 of IEC 60384-14, prepared by IEC TC 40, Capacitors and resistors for electronic equipment, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60384-14 on 2005-07-01.

This European Standard supersedes EN 132400:1994 + A2:1998 + A3:1998 + A4:2001.

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2006-05-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2008-07-01 |

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60384-14:2005 was approved by CENELEC as a European Standard without any modification.

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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-DB¹, *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.

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 $C_R \leq 1,0 \mu\text{F}$ $U_P = 4 \text{ kV}$ When $C_R > 1,0 \mu\text{F}$ $U_P = \frac{4}{\sqrt{\frac{C_R}{10^{-6} \text{ F}}}} \text{ kV}$
X2	≤ 2,5 kV	II	General purpose	When $C_R \leq 1,0 \mu\text{F}$ $U_P = 2,5 \text{ kV}$ When $C_R > 1,0 \mu\text{F}$ $U_P = \frac{2,5}{\sqrt{\frac{C_R}{10^{-6} \text{ F}}}} \text{ kV}$
X3	≤ 1,2 kV	-	General purpose	None

NOTE The factor used for the reduction of U_P for capacitance values above $1,0 \mu\text{F}$ maintains $\frac{1}{2} \times C_R U_P^2$ 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)

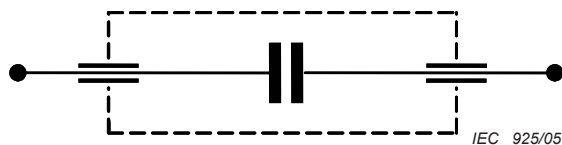


Figure 1 – Two-terminal capacitor

1.5.6

series RC unit

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

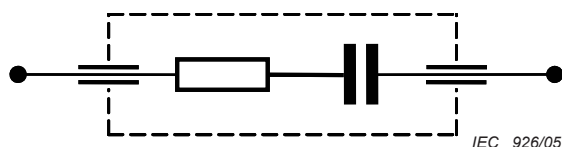


Figure 2 – RC unit

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)

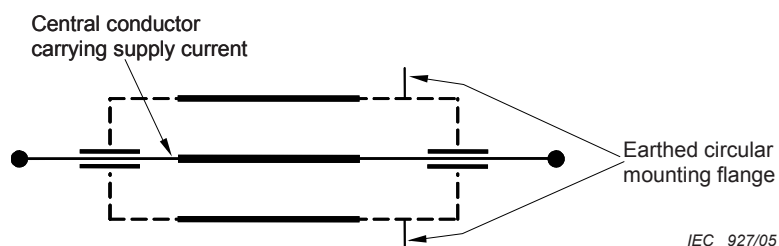


Figure 3 – Lead-through capacitor (coaxial)

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)

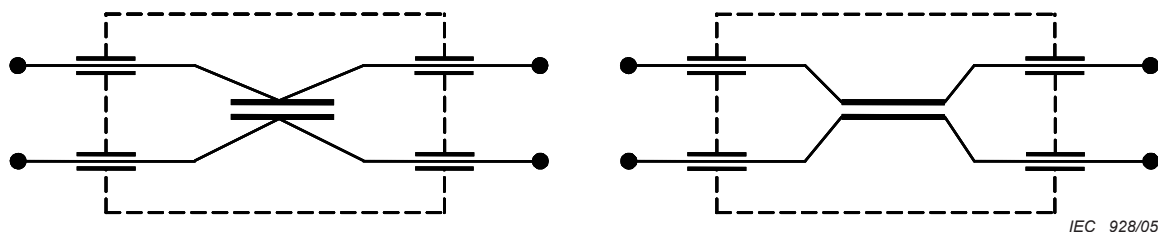


Figure 4a – Lead-through capacitor for symmetrical use (non-coaxial)

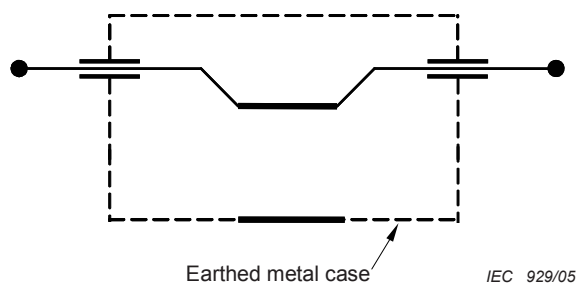


Figure 4b – Lead-through capacitor for asymmetrical use (non-coaxial)

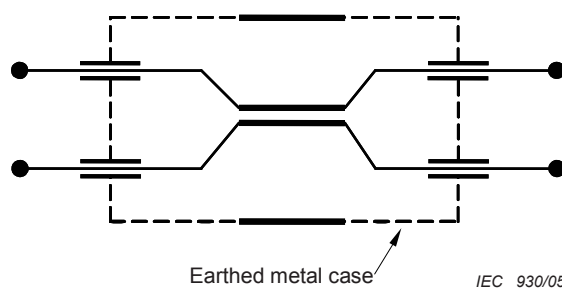
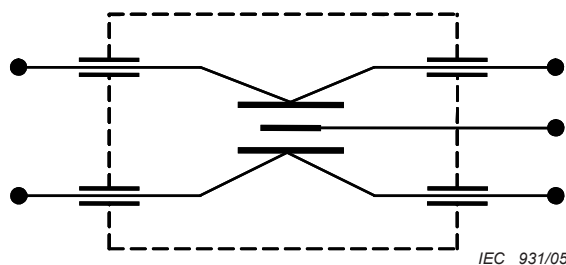
Figure 4c – Multiple unit lead-through capacitor (non-coaxial)
for symmetrical and asymmetrical use

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.

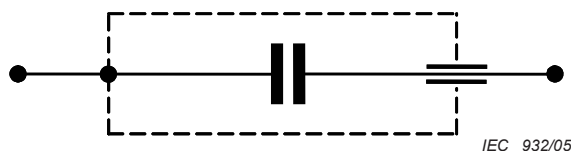


Figure 5a – Single by-pass capacitor

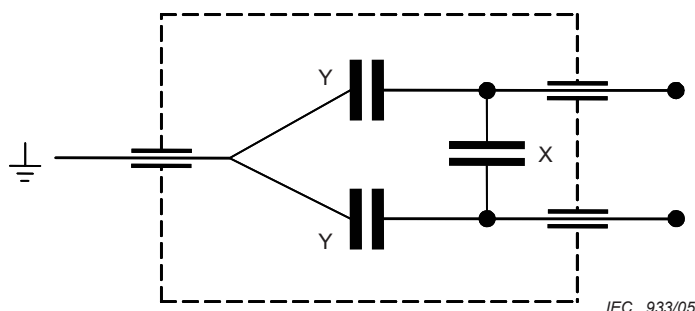


Figure 5b – Delta by-pass capacitor

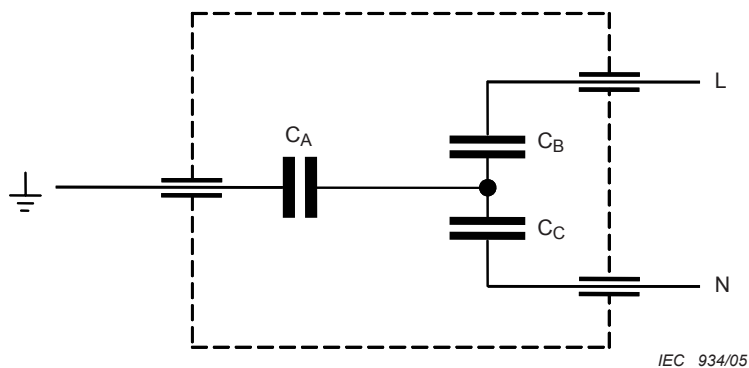


Figure 5c – Example of a T-connected by-pass capacitor

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 $\pm 20\%$;
- 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), $\tan \delta$ 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.