

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Fixed capacitors for use in electronic equipment –  
Part 22: Sectional specification – Fixed surface mount multilayer capacitors of  
ceramic dielectric, Class 2**

**Condensateurs fixes utilisés dans les équipements électroniques –  
Partie 22: Spécification intermédiaire – Condensateurs multicouches fixes à  
diélectriques en céramique pour montage en surface, de Classe 2**



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2011 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland  
Email: [inmail@iec.ch](mailto:inmail@iec.ch)  
Web: [www.iec.ch](http://www.iec.ch)

### About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

### About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: [www.iec.ch/online\\_news/justpub](http://www.iec.ch/online_news/justpub)

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: [www.iec.ch/webstore/custserv](http://www.iec.ch/webstore/custserv)

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: [csc@iec.ch](mailto:csc@iec.ch)  
Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00

### A propos de la CEI

La Commission Electrotechnique internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

### A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: [www.iec.ch/searchpub/cur\\_fut-f.htm](http://www.iec.ch/searchpub/cur_fut-f.htm)

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,...). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: [www.iec.ch/online\\_news/justpub](http://www.iec.ch/online_news/justpub)

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: [www.iec.ch/webstore/custserv/custserv\\_entry-f.htm](http://www.iec.ch/webstore/custserv/custserv_entry-f.htm)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:

Email: [csc@iec.ch](mailto:csc@iec.ch)  
Tél.: +41 22 919 02 11  
Fax: +41 22 919 03 00

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Fixed capacitors for use in electronic equipment –  
Part 22: Sectional specification – Fixed surface mount multilayer capacitors of  
ceramic dielectric, Class 2**

**Condensateurs fixes utilisés dans les équipements électroniques –  
Partie 22: Spécification intermédiaire – Condensateurs multicouches fixes à  
diélectriques en céramique pour montage en surface, de Classe 2**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

PRICE CODE  
CODE PRIX



## CONTENTS

FOREWORD.....	6
1 General.....	8
1.1 Scope.....	8
1.2 Object.....	8
1.3 Normative references.....	8
1.4 Information to be given in a detail specification.....	8
1.4.1 Outline drawing and dimensions.....	9
1.4.2 Mounting.....	9
1.4.3 Rating and characteristics.....	9
1.4.4 Marking.....	10
1.5 Terms and definitions.....	10
1.6 Marking.....	10
1.6.1 Information for marking.....	11
1.6.2 Marking on the body.....	11
1.6.3 Requirements for marking.....	11
1.6.4 Marking of the packaging.....	11
1.6.5 Additional marking.....	11
2 Preferred rating and characteristics.....	11
2.1 Preferred characteristics.....	11
2.1.1 Preferred climatic categories.....	11
2.2 Preferred values of ratings.....	12
2.2.1 Rated temperature ( $T_R$ ).....	12
2.2.2 Rated voltage ( $U_R$ ).....	12
2.2.3 Category voltage ( $U_C$ ).....	12
2.2.4 Preferred values of nominal capacitance and associated tolerance values.....	12
2.2.5 Temperature characteristic of capacitance.....	13
2.2.6 Dimensions.....	14
3 Quality assessment procedures.....	14
3.1 Primary stage of manufacture.....	14
3.2 Structurally similar components.....	14
3.3 Certified records of released lots.....	14
3.4 Qualification approval.....	14
3.4.1 Qualification approval on the basis of the fixed sample size procedures.....	14
3.4.2 Tests.....	15
3.5 Quality conformance inspection.....	20
3.5.1 Formation of inspection lots.....	20
3.5.2 Test schedule.....	20
3.5.3 Delayed delivery.....	20
3.5.4 Assessment levels.....	20
4 Test and measurement procedures.....	22
4.1 Special preconditioning.....	22
4.2 Measuring conditions.....	22
4.3 Mounting.....	22
4.4 Visual examination and check of dimensions.....	22
4.4.1 Visual examination.....	22

4.4.2	Requirements .....	22
4.5	Electrical tests.....	24
4.5.1	Capacitance .....	24
4.5.2	Tangent of loss angle ( $\tan \delta$ ) .....	25
4.5.3	Insulation resistance.....	25
4.5.4	Voltage proof.....	26
4.5.5	Impedance (if required by the detail specification) .....	27
4.5.6	Equivalent series resistance [ESR] (if required by the detail specification) .....	27
4.6	Temperature characteristic of capacitance .....	27
4.6.1	Special preconditioning .....	27
4.6.2	Measuring conditions.....	27
4.6.3	Requirements .....	28
4.7	Shear test .....	28
4.8	Substrate bending test .....	28
4.8.1	Initial measurement .....	28
4.8.2	Final inspection .....	28
4.9	Resistance to soldering heat .....	29
4.9.1	Special preconditioning .....	29
4.9.2	Initial measurement .....	29
4.9.3	Test conditions .....	29
4.9.4	Recovery.....	30
4.9.5	Final inspection, measurements and requirements .....	30
4.10	Solderability .....	31
4.10.1	Test conditions .....	31
4.10.2	Recovery .....	32
4.10.3	Final inspection, measurements and requirements .....	32
4.11	Rapid change of temperature .....	32
4.11.1	Special preconditioning .....	32
4.11.2	Initial measurement .....	32
4.11.3	Number of cycles.....	32
4.11.4	Recovery .....	32
4.11.5	Final inspection, measurements and requirements .....	32
4.12	Climatic sequence .....	33
4.12.1	Special preconditioning .....	33
4.12.2	Initial measurement .....	33
4.12.3	Dry heat .....	33
4.12.4	Damp heat, cyclic, Test Db, first cycle .....	33
4.12.5	Cold .....	33
4.12.6	Damp heat, cyclic, Test Db, remaining cycles .....	33
4.12.7	Final inspection, measurements and requirements .....	34
4.13	Damp heat, steady state.....	34
4.13.1	Special preconditioning .....	34
4.13.2	Initial measurement .....	34
4.13.3	Conditions of test .....	34
4.13.4	Recovery .....	35
4.13.5	Final inspection, measurements and requirements .....	35
4.14	Endurance.....	35
4.14.1	Special preconditioning .....	35

4.14.2	Initial measurement .....	36
4.14.3	Conditions of test .....	36
4.14.4	Recovery .....	36
4.14.5	Final inspection, measurements and requirements .....	36
4.15	Robustness of terminations (only for capacitors with strip termination) .....	37
4.15.1	Test conditions .....	37
4.15.2	Final inspection and requirements .....	37
4.16	Component solvent resistance (if required).....	37
4.17	Solvent resistance of the marking (if required).....	37
4.18	Accelerated damp heat, steady state (if required).....	37
4.18.1	Initial measurement .....	37
4.18.2	Conditioning .....	38
4.18.3	Recovery .....	38
4.18.4	Final measurements .....	38
Annex A (normative)	Guidance for the specification and coding of dimensions of fixed surface mount multilayer capacitors of ceramic dielectric, Class 2 .....	39
Annex B (informative)	Capacitance ageing of fixed capacitors of ceramic dielectric, Class 2 .....	40
Annex C (informative)	Temperature characteristics of capacitance for the reference temperature of 25 °C .....	42
Bibliography	.....	43
Figure 1	– Fault: crack or fissure .....	23
Figure 2	– Fault: crack or fissure .....	23
Figure 3	– Separation or delamination .....	23
Figure 4	– Exposed electrodes .....	23
Figure 5	– Principal faces .....	24
Figure 6	– Reflow temperature profile .....	30
Figure A.1	– Dimensions .....	39
Table 1	– Preferred values of category voltages .....	12
Table 2	– Preferred tolerances .....	13
Table 3	– Temperature characteristic of capacitance .....	13
Table 4	– Fixed sample size test plan for qualification approval, assessment level EZ .....	16
Table 5	– Tests schedule for qualification approval .....	17
Table 6a	– Lot-by-lot inspection .....	21
Table 6b	– Periodic test .....	21
Table 7	– Measuring conditions .....	24
Table 8	– Tangent of loss angle limits .....	25
Table 9	– Test voltages .....	26
Table 10	– Details of measuring conditions .....	27
Table 11	– Reflow temperature profiles for Sn-Ag-Cu alloy .....	30
Table 12	– Maximum capacitance change .....	31
Table 13	– Maximum capacitance change .....	33
Table 14	– Number of damp heat cycles .....	33
Table 15	– Final inspection, measurements and requirements .....	34

Table 16 – Test conditions for damp heat, steady state.....	35
Table 17 – Final inspection, measurements and requirements .....	35
Table 18 – Endurance test conditions ( $U_C = U_R$ ) .....	36
Table 19 – Endurance test conditions ( $U_C \neq U_R$ ) .....	36
Table 20 – Final inspection, measurements and requirements of endurance test .....	37
Table 21 – Initial requirements.....	38
Table 22 – Conditioning .....	38
Table A.1 – Dimensions .....	39
Table C.1 – Temperature characteristics of capacitance for the reference temperature of 25 °C .....	42
Table C.2 – Measuring conditions of temperature characteristic of capacitance for the reference temperature of 25 °C.....	42

iTeh STANDARD PREVIEW  
(standards.iteh.ai)

IEC 60384-22:2011

<https://standards.iteh.ai/catalog/standards/sist/62bbf71-7a97-4fb5-89de-81be7815415f/iec-60384-22-2011>

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –****Part 22: Sectional specification – Fixed surface mount  
multilayer capacitors of ceramic dielectric, Class 2**

## 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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60384-22 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This second edition cancels and replaces the first edition published in 2004 and contains the following significant technical changes with respect to the previous edition.

- The measuring frequency of 1 MHz has been reduced to 1 kHz for 100 pF, see 4.5.1 Capacitance.
- The test voltage of  $1,2 U_R$  at  $U_R \geq 1\,000\text{ V}$  has been added in 4.5.4 Voltage proof.
- Detail test conditions have been added in 4.7 Shear test and 4.8 Substrate bending test.
- Test conditions applying lead free solder alloy (Sn-Ag-Cu) have been included in 4.9 Resistance to soldering heat and 4.10 Solderability.
- A selection of the test conditions according to marketing needs has been stated in 4.13 Damp heat, steady state.



- The dimensions of 0402 M in Annex A have been added.
- The temperature characteristics code of capacitance for the reference temperature of 25 °C has been added, see Annex C.

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

FDIS	Report on voting
40/2128/FDIS	40/2141/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.

The list of all parts of the IEC 60384 series, under the general title *Fixed capacitors for use in electronic equipment*, can be found on the IEC web site.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

<https://standards.iteh.ai/catalog/standards/sist/60384-22-2011>  
<https://standards.iteh.ai/catalog/standards/sist/60384-22-2011>

# FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

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

### 1 General

#### 1.1 Scope

This part of IEC 60384 is applicable to fixed unencapsulated surface mount multilayer capacitors of ceramic dielectric, Class 2, for use in electronic equipment. These capacitors have metallized connecting pads or soldering strips and are intended to be mounted on printed boards, or directly onto substrates for hybrid circuits.

Capacitors for electromagnetic interference suppression are not included, but are covered by IEC 60384-14.

#### 1.2 Object

The 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 should be of equal or higher performance level, lower performance levels are not permitted.

#### 1.3 Normative references

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

IEC 60063:1963, *Preferred number series for resistors and capacitors*  
Amendment 1 (1967)  
Amendment 2 (1977)

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*  
Amendment 1 (1992)

IEC 60068-2-58:2004, *Environmental testing – Part 2-58: Tests – Test Td – Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60384-1:2008, *Fixed capacitors for use in electronic equipment – Part 1: Generic specification*

IEC 61193-2:2007, *Quality assessment systems – Part 2: Selection and use of sampling plans for inspection of electronic components and packages*

ISO 3:1973, *Preferred numbers – Series of preferred numbers*

#### 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.

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

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

#### **1.4.1 Outline drawing and dimensions**

There shall be an illustration of the capacitors as an aid to easy recognition and for comparison of the capacitors 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. When necessary, for example when a number of items (sizes and capacitance/voltage ranges) are covered by a detail specification, the dimensions and their associated tolerances shall be placed in a table below the drawing.

When the configuration is other than described above, the detail specification shall state such dimensional information as will adequately describe the capacitors.

#### **1.4.2 Mounting**

The detail specification shall give guidance on methods of mounting for normal use. Mounting for test and measurement purposes (when required) shall be in accordance with 4.3 of this sectional specification.

#### **1.4.3 Rating 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 Nominal capacitance range**

See 2.2.4.1.

NOTE When products approved to the detail specification have different ranges, the following statement should be added: "The range of capacitance values available in each voltage range is given in the register of approvals, available for example on the website [www.iecq.org](http://www.iecq.org)".

##### **1.4.3.2 Particular characteristics**

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

##### **1.4.3.3 Soldering**

The detail specification shall prescribe the test methods, severities and requirements applicable for the solderability and the resistance to soldering heat tests.

#### 1.4.4 Marking

The detail specification shall specify the content of the marking on the capacitor and on the package. Deviations from 1.6 of this sectional specification shall be specifically stated.

### 1.5 Terms and definitions

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

#### 1.5.1

##### **surface mount capacitor**

capacitor whose small dimensions and nature or shape of terminations make it suitable for surface mounting in hybrid circuits and on printed boards

#### 1.5.2

##### **fixed capacitors, ceramic dielectric, Class 2**

capacitor which has a dielectric with a high permittivity and is suitable for by-pass and coupling applications or for frequency discriminating circuits where low losses and high stability of capacitance are not of major importance

NOTE The ceramic dielectric is characterized by a non linear change of capacitance over the category temperature range (see Table 3).

#### 1.5.3

##### **subclass**

maximum percentage change of capacitance within the category temperature range with respect to the capacitance at 20 °C

NOTE The subclass may be expressed in code form (see Table 3).

#### 1.5.4

##### **category temperature range**

range of ambient temperatures for which the capacitor has been designed to operate continuously; this is given by the lower and upper category temperature

#### 1.5.5

##### **rated temperature**

$T_R$

maximum ambient temperature at which the rated voltage may be continuously applied

#### 1.5.6

##### **rated d.c. voltage**

$U_R$

maximum d.c. voltage which may be applied continuously to a capacitor at any temperature between the lower category temperature and the rated temperature

NOTE Maximum d.c. voltage is the sum of the d.c. voltage and peak a.c. voltage or peak pulse voltage applied to the capacitor.

#### 1.5.7

##### **category voltage**

$U_C$

maximum voltage which may be applied continuously to a capacitor at its upper category temperature

### 1.6 Marking

See IEC 60384-1, 2.4, with the following details.

### 1.6.1 Information for marking

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:

- nominal capacitance;
- rated voltage (d.c. voltage may be indicated by the symbol (  $\text{---}$  or  $\text{—}$  ));
- tolerance on nominal capacitance;
- dielectric subclass as applicable (according to 2.2.5);
- year and month (or week) of manufacture;
- manufacturer's name or trade mark;
- climatic category;
- manufacturer's type designation;
- reference to the detail specification.

### 1.6.2 Marking on the body

These capacitors are generally not marked on the body. If some marking can be applied, they shall be clearly marked with as many as possible of the above items as is considered useful. Any duplication of information in the marking on the capacitor should be avoided.

### 1.6.3 Requirements for marking

Any marking shall be legible and not easily smeared or removed by rubbing with the finger.

### 1.6.4 Marking of the packaging

The packaging containing the capacitor(s) shall be clearly marked with all the information listed in 1.6.1.

### 1.6.5 Additional marking

Any additional marking shall be so applied that no confusion can arise.

## 2 Preferred rating and characteristics

### 2.1 Preferred characteristics

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

#### 2.1.1 Preferred climatic categories

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

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

- lower category temperature:  $-55\text{ }^{\circ}\text{C}$ ,  $-40\text{ }^{\circ}\text{C}$ ,  $-25\text{ }^{\circ}\text{C}$ ,  $0\text{ }^{\circ}\text{C}$  and  $+10\text{ }^{\circ}\text{C}$ ;
- upper category temperature:  $+70\text{ }^{\circ}\text{C}$ ,  $+85\text{ }^{\circ}\text{C}$ ,  $+100\text{ }^{\circ}\text{C}$ ,  $+125\text{ }^{\circ}\text{C}$  and  $+150\text{ }^{\circ}\text{C}$ ;
- duration of the damp heat, steady state test ( $40\text{ }^{\circ}\text{C}$ , 93 % RH): 4, 10, 21 and 56 days.

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

NOTE The resistance to humidity resulting from the above climatic category is for the capacitors in their unmounted state. The climatic performance of the capacitors after mounting is greatly influenced by the mounting substrate, the mounting method (see 4.3) and the final coating.

## 2.2 Preferred values of ratings

### 2.2.1 Rated temperature ( $T_R$ )

The rated temperature is equal to the upper category temperature for capacitors with the upper category temperature not exceeding 125 °C, unless otherwise stated in the detail specification.

### 2.2.2 Rated voltage ( $U_R$ )

The preferred values of the rated voltage are the values of the R5 series of ISO 3. If other values are needed they shall be chosen from the R10 series.

The sum of the d.c. voltage and the peak a.c. voltage or the peak to peak a.c. voltage, whichever is the greater, applied to the capacitor shall not exceed the rated voltage. The value of the peak a.c. voltage shall not exceed the value determined by the permissible reactive power.

### 2.2.3 Category voltage ( $U_C$ )

The category voltage is equal to the rated voltage for capacitors with the upper category temperature not exceeding 125 °C. Any category voltages which are different from the rated voltage, for capacitors with the upper category temperature exceeding 125 °C or for high voltage capacitors with rated voltages above 500 V, shall be given by the detail specification.

The preferred values of the category voltage at 125 °C upper category temperature for high volumetric capacitors with a rated voltage of 16 V and less and a rated temperature of 85 °C are given in Table 1.

**Table 1 – Preferred values of category voltages**

$U_R$	V	2,5	4	6,3	10	16
$U_C$	V	1,6	2,5	4	6,3	10
NOTE The numeric values of $U_C$ are calculated by the following: $U_C = 0,63 \times U_R.$						

### 2.2.4 Preferred values of nominal capacitance and associated tolerance values

#### 2.2.4.1 Preferred values of nominal capacitance

Nominal capacitance values shall be taken from the series of IEC 60063; the E3, E6 and E12 series are preferred.

#### 2.2.4.2 Preferred tolerances on nominal capacitance

See Table 2.

**Table 2 – Preferred tolerances**

Preferred series	Tolerance %	Letter code
E3 and E6	-20/+80	Z
	-20/+50	S
E6	±20	M
E6 and E12	±10	K

### 2.2.5 Temperature characteristic of capacitance

Table 3 denotes with a cross the preferred values of the temperature characteristic with and without a d.c. voltage applied. The method of coding the subclass is also given, for example a dielectric with a percentage change of  $\pm 20$  % without d.c. voltage applied over the temperature range from  $-55$  °C to  $+125$  °C will be defined as a dielectric of subclass 2C1.

The temperature range for which the temperature characteristic of the dielectric is defined is the same as the category temperature range.

**Table 3 – Temperature characteristic of capacitance**

Sub-class letter code	Maximum capacitance change within the category temperature range with respect to the capacitance at 20 °C measured with and without a d.c. voltage applied %		Category temperature range and corresponding number code					
			-55/+150 °C	-55/+125 °C	-55/+85 °C	-40/+85 °C	-25/+85 °C	+10/+85 °C
	without d.c. voltage applied	with d.c. voltage applied (NOTE 1)	0	1	2	3	4	6
2B	± 10	Requirements specified in the detail specification			x	x	x	
2C	± 20			x	x	x		
2D	+20/-30			x			x	
2E	+22/-56				x	x	x	x
2F	+30/-80				x	x	x	x
2R	± 15			x	x	x	x	

NOTE 1 d.c. voltage applied is either rated voltage or the voltage specified in the detail specification.

NOTE 2 "x" indicates preferred.

NOTE 3 When the upper category temperature is above 125 °C, the limits of capacitance change, both with and without d.c. voltage applied should be given in the detail specification.

NOTE See Annex C for the reference temperature of 25 °C as informative guide.