

# INTERNATIONAL STANDARD

**IEC**  
**60384-24**

First edition  
2006-06

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**Fixed capacitors for use in electronic equipment –**

**Part 24:**

**Sectional specification –**

**Surface mount fixed tantalum electrolytic  
capacitors with conductive polymer solid  
electrolyte**

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Reference number  
IEC 60384-24:2006(E)

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## Fixed capacitors for use in electronic equipment –

### Part 24:

### Sectional specification – Surface mount fixed tantalum electrolytic capacitors with conductive polymer solid electrolyte

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## CONTENTS

FOREWORD.....	3
1 General.....	6
1.1 Scope.....	6
1.2 Object.....	6
1.3 Normative references.....	6
1.4 Information to be given in a detail specification.....	7
1.5 Terms and definitions.....	8
1.6 Marking.....	8
2 Preferred rating and characteristics.....	8
2.1 Preferred characteristics.....	8
2.2 Preferred values of ratings.....	9
3 Quality assessment procedures.....	10
3.1 Primary stage of manufacture.....	10
3.2 Structurally similar components.....	10
3.3 Declaration conformity (basic requirements).....	10
3.4 Test schedule and requirement for initial assessment (mandatory and optional tests).....	10
3.5 Quality conformance inspection.....	19
4 Test and measurement procedures.....	20
4.1 Preliminary drying.....	20
4.2 Measuring conditions.....	21
4.3 Mounting.....	21
4.4 Visual examination and check of dimensions.....	21
4.5 Electrical tests.....	21
4.6 Resistance to soldering heat.....	22
4.7 Solderability.....	23
4.8 Shear test.....	23
4.9 Substrate bending test.....	23
4.10 Rapid change of temperature.....	23
4.11 Climatic sequence.....	24
4.12 Damp heat, steady state.....	24
4.13 Characteristics at high and low temperature.....	25
4.14 Surge.....	25
4.15 Endurance.....	25
4.16 Component solvent resistance (if applicable).....	26
4.17 Solvent resistance of marking (if applicable).....	26
4.18 High surge current (if applicable).....	26
4.19 Storage at high temperature.....	26

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –****Part 24: Sectional specification – Surface mount fixed tantalum electrolytic capacitors with conductive polymer solid electrolyte**

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International Standard IEC 60384-24 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

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

FDIS	Report on voting
40/1731/FDIS	40/1754/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: Sectional specification: Fixed polyethylene-terephthalate film dielectric metal foil d.c. capacitors
- 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 sulphide 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
- Part 23: Sectional specification: Fixed surface mount metallized polyethylene naphthalate film dielectric d.c. capacitors
- Part 24: Sectional specification: Surface mount fixed tantalum electrolytic capacitors with conductive polymer solid electrolyte
- Part 25: Sectional specification: Surface mount fixed aluminium electrolyte capacitors with conductive polymer solid electrolyte

All sectional specifications mentioned above do have one or more blank detail specifications being a supplementary document, containing requirements for style, layout and minimum content of detail specifications.

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 publication may be issued at a later date.

The contents of the corrigendum of October 2006 have been included in this copy.

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Withdrawn

## FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

### Part 24: Sectional specification – Surface mount fixed tantalum electrolytic capacitors with conductive polymer solid electrolyte

#### 1 General

##### 1.1 Scope

This part of IEC 60384 is applicable to tantalum electrolytic capacitors with conductive polymer solid electrolyte. These capacitors are primarily intended to be mounted direct on to substrates for hybrid circuits or to printed boards.

Fixed tantalum electrolytic chip capacitors with solid ( $\text{MnO}_2$ ) are not included but are covered by IEC 60384-3.

##### 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 shall be of equal or higher performance level, because lower performance levels are not permitted.

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

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

IEC 60068-2-14: *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

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 60384-1:1999, *Fixed capacitors for use in electronic equipment – Part 1: Generic specification*

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

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 surface mount capacitors as an aid to easy recognition and for comparison of the surface mount 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 case sizes 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 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 capacitance values available in each voltage range is given in IEC QC 001005".

#### 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 of 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

#### 1.6 Marking

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

**1.6.1** 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) polarity of the terminations (unless identified by the construction);
- b) rated capacitance;
- c) rated voltage (d.c. voltage may be indicated by the symbol  $\overline{\text{---}}$  or  $\text{---}$ );
- d) tolerance on rated capacitance;
- e) year and month (or week) of manufacture;
- f) manufacturer's name or trade mark;
- g) climatic category;
- h) manufacturer's type designation;
- i) reference to the detail specification.

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

**1.6.4** The package containing the capacitor(s) shall be clearly marked with all the information listed in 1.6.1, except polarity, unless this is applicable to the method of packaging.

**1.6.5** 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 surface mount 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 temperatures and the duration of the damp heat, steady state test shall be chosen from the following:

Lower category temperature:	-55 °C
Upper category temperature:	+105 °C and +125 °C
Duration of the damp heat, steady state test:	21 days

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

The rated temperature shall be 85 °C or 105 °C for upper category temperature of 125 °C. The rated temperature shall be 85 °C for an upper category temperature of 105 °C.

## 2.2 Preferred values of ratings

### 2.2.1 Rated capacitance ( $C_R$ )

Preferred values of rated capacitance are the values the E6 and E12 series of IEC 60063 and their decimal multiples ( $\times 10^n$ ,  $n$ : integer).

### 2.2.2 Tolerance on rated capacitance

Preferred values of tolerance on rated capacitance are:  $\pm 20$  %.

### 2.2.3 Rated voltage ( $U_R$ )

The preferred values of the rated voltage are the values of the R10 series of ISO 3: 1,0 – 1,25 – 1,6 – 2,0 – 2,5 – 3,15 – 4,0 – 5,0 – 6,3 – 8,0 and their decimal multiples ( $\times 10^n$ ,  $n$ : integer).

### 2.2.4 Category voltage ( $U_C$ )

The category voltage for capacitors is given in Table 1.

**Table 1 – Category voltages**

Temperature/ Voltage	Value		
	$T_{UC}$ (°C)	125	105
$T_R$ (°C)	85	85	105
$U_R$ (V)	$1,0 \times U_R$	$1,0 \times U_R$	
$U_{RS}$ (V)	$1,15 \times U_R$	$1,15 \times U_R$	
$U_C$ (V)	$0,8 \times U_R$	$0,9 \times U_R$	
$U_{CS}$ (V)	$0,92 \times U_R$	$1,03 \times U_R$	

### 2.2.5 Surge voltage ( $U_{RS}$ or $U_{CS}$ )

The surge voltage shall be 1,15 times the rated or category voltage rounded off to the nearest volt (see Table 1).

NOTE  $U_{RS}$  is the surge voltage to rated voltage;  
 $U_{CS}$  is the the surge voltage to category voltage.

### 2.2.6 Rated temperature

The value of the rated temperature is +85 °C and +105 °C.

## 3 Quality assessment procedures

### 3.1 Primary stage of manufacture

The primary stage of manufacture is the forming of the oxide film.

### 3.2 Structurally similar components

Capacitors considered as being structurally similar are capacitors produced with similar processes and materials, though they may be of different case sizes and values.

### 3.3 Declaration conformity (basic requirements)

### 3.4 Test schedule and requirement for initial assessment (mandatory and optional tests)

The procedures for qualification approval testing are given in IEC 60384-1, 3.5.

The schedule to be used for qualification approval testing on the basis of lot-by-lot and periodic tests is given in 3.5 of this specification. The procedure using a fixed sample size schedule is given in 3.4.1 and 3.4.2 below.

#### 3.4.1 Qualification approval on the basis of the fixed sample size procedures

The fixed sample size procedure is described in IEC 60410. The sample shall be representative of the range of capacitors for which approval is sought. This may or may not be the complete range covered by the detail specification.

For each temperature characteristic the sample shall consist of specimens of capacitors of maximum and minimum size and, for each of these sizes, the maximum capacitance value for the highest rated voltage and minimum rated voltage of the voltage ranges for which approval is sought. When there are more than four rated voltages, an intermediate voltage shall also be tested. Thus, for the approval of a range, testing is required of either four or six values (capacitance/voltage combinations) for each temperature characteristic. Where the total range consists of less than four values the number of specimens to be tested shall be that required for four values.

In the case where assessment level EZ is used, spare specimens are permitted as follows.

Two (for six values) or three (for four values) per value which may be used as replacements for specimens, which are non-conforming because of incidents not attributable to the manufacturer.

The numbers given in Group 0 assume that all groups 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.

Table 2 gives the number of samples to be tested in each group or subgroup together with the number of permissible non-conformances for qualification approval test.

### 3.4.2 Tests

The complete series of tests specified in Tables 2 and 3 are required for the approval of capacitors 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 divided for the other groups.

Non-conforming (Table 2) specimens found during the tests of Group 0 shall not be used for the other groups.

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

Approval is granted when the number of non-conforming items does not exceed the specified number of permissible non-conforming items for each group or subgroup and the total number of permissible non-conformances.

NOTE Tables 2 and 3 together form the fixed sample size test schedule. Table 2 includes the details for the sampling and permissible defectives for the different tests or groups of tests. Table 3, together with the details of test contained in Clause 4, gives a complete summary of test conditions and performance requirements and indicates where, for example, for the test method 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 test schedule should be identical to those prescribed in the detail specification for quality conformance inspection.

**Table 2 – Fixed sample size test plan for qualification approval – Assessment level EZ**

Group No.	Test	Subclause of this publication	Number of specimens <i>n</i> <sup>d</sup>	Permissible number of non-conforming items <sup>b</sup>
0	High surge current <sup>c</sup>	4.18	120	0
	Visual examination	4.4		
	Dimensions	4.4		
	Leakage current	4.5.1		
	Capacitance	4.5.2		
	Tangent of loss angle	4.5.3		
	Equivalent series resistance <sup>c</sup>	4.5.4		
	Spare specimens			
1A	Resistance to soldering heat	4.6	12	0
	Component solvent resistance <sup>f</sup>	4.16		
1B	Solderability	4.7	12	0
	Solvent resistance of marking <sup>f</sup>	4.17		
2	Substrate bending test <sup>e</sup>	4.9	12	0
3 <sup>a</sup>	Mounting	4.3	84	0 <sup>b</sup>
	Visual examination	4.4		
	Leakage current	4.5.1		
	Capacitance	4.5.2		
	Tangent of loss angle	4.5.3		
	Equivalent series resistance <sup>c</sup>	4.5.4		
3.1	Shear test	4.8	12	0
	Rapid change of temperature	4.10		
	Climatic sequence	4.11		
3.2	Damp heat, steady state	4.12	12	0
3.3	Characteristics at high and low temperature	4.13	12	0
	Surge	4.14		
3.4	Endurance	4.15	36	0
3.5	Storage at high temperature	4.19	12	0
<p><sup>a</sup> The values of these measurements serve as initial measurements for the tests of Group 3.</p> <p><sup>b</sup> The capacitors found non-conforming after mounting shall not be taken into account when calculating the permissible non-conforming items for the following tests. They shall be replaced by spare capacitors.</p> <p><sup>c</sup> If required in the detail specification.</p> <p><sup>d</sup> For capacitance/voltage combinations, see 3.4.1.</p> <p><sup>e</sup> Not applicable to capacitors which, according to their detail specification, shall only be mounted on alumina substrates.</p> <p><sup>f</sup> If applicable.</p>				

**Table 3 – Test schedule for qualification approval**

Subclause number and test <sup>a</sup>	D or ND <sup>b</sup>	Conditions of test <sup>a</sup>	Number of specimens ( <i>n</i> ) and number of non-conforming items ( <i>c</i> )	Performance requirements <sup>a</sup>
<b>GROUP 0</b>	ND		See Table 2	
4.18 High surge current (if required in the detail specification)				
4.4 Visual examination				As in 4.4.2 Legible marking and as specified in the detail specification
4.4 Dimension (detail)				See the detail specification
4.5.1 Leakage current		Protective resistor: 1 000 Ω		As in 4.5.1.2
4.5.2 Capacitance		Frequency: 120 Hz		As in 4.5.2
4.5.3 Tangent of loss angle (tan δ)		Frequency: 120 Hz		As in 4.5.3
4.5.4 Equivalent series resistance (if required in the detail specification)		Frequency: 100 kHz		See detail specification
<b>GROUP 1A</b>	D		See Table 2	
4.6 Resistance to soldering heat		Method: Duration: Recovery: 24 h ± 2 h		
4.6.3 Final measurement		Visual examination Capacitance Tangent of loss angle		As in 4.6.3 See detail specification See detail specification
4.16 Component solvent resistance (if required in the detail specification)		Solvent: ... Solvent temperature: ... Method 2 Recovery: ...		See detail specification See detail specification

**Table 3 – Tests schedule for qualification approval (continued)**

Subclause number and test <sup>a</sup>	D or ND <sup>b</sup>	Conditions of test <sup>a</sup>	Number of specimens ( <i>n</i> ) and number of non-conforming items ( <i>c</i> )	Performance requirements <sup>a</sup>
<b>GROUP 1B</b> 4.7 Solderability 4.7.2 Final measurements 4.17 Solvent resistance of the marking <sup>c</sup> (if required in the detail specification)	D	See detail specification for the method Visual examination Solvent: ... Solvent temperature: ... Method 1 Rubbing material: cotton wool Recovery: ...	See Table 2	As in 4.7.2 Legible marking
<b>GROUP 2</b> 4.9 Substrate bending test 4.9.1 Initial measurement 4.9.2 Final inspection	D	Deflection: ... Capacitance Visual examination Capacitance (with printed board in bent position)	See Table 2	No visible damage See detail specification
<b>GROUP 3</b> 4.3 Mounting	D	Substrate material: ... <sup>9</sup> Visual examination Leakage current Capacitance Tangent of loss angle Equivalent series resistance (if applicable)	See Table 2	No visible damage See detail specification $\Delta C/C < 8\%$ of value measured in 4.5.2 See detail specification See detail specification

Table 3 – Tests schedule for qualification approval (continued)

Subclause number and test <sup>a</sup>	D or ND <sup>b</sup>	Conditions of test <sup>a</sup>	Number of specimens ( <i>n</i> ) and number of non-conforming items ( <i>c</i> )	Performance requirements <sup>a</sup>
<b>GROUP 3.1</b> 4.8 Shear test 4.10.1 Initial measurement 4.10 Rapid change of temperature 4.10.3 Final measurements 4.11 Climatic sequence 4.11.1 Initial measurement 4.11.2 Dry heat 4.11.3 Damp heat, cyclic, test Db, first cycle 4.11.4 Cold 4.11.5 Damp heat, cyclic, test Db, remaining cycles 4.11.6 Final measurements	D	Visual examination Capacitance $T_A$ = Lower category temperature $T_B$ = Upper category temperature Five cycles Duration $t_1$ = 30 min Recovery: 1 h to 2h Leakage current Capacitance Tangent of loss angle Capacitance Temperature: upper category temperature Duration: 16 h Temperature: lower category temperature Duration: 2 h Recovery: 1h to 2h Visual examination Capacitance Tangent of loss angle	See Table 2	No visible damage See detail specification $\Delta C/C < 10$ % of the value measured in 4.10.1 See detail specification No visible damage Legible marking $\Delta C/C < \pm 20$ % of the value measured in 4.11.1 See detail specification

**Table 3 – Tests schedule for qualification approval (continued)**

Subclause number and test <sup>a</sup>	D or ND <sup>b</sup>	Conditions of test <sup>a</sup>	Number of specimens ( <i>n</i> ) and number of non-conforming items ( <i>c</i> )	Performance requirements <sup>a</sup>
<b>GROUP 3.2</b> 4.12 Damp heat, steady state 4.12.1 Initial measurement 4.12.3 Final measurements	D	Recovery: 1 h to 2 h Duration: 21 d  Capacitance Visual examination  Leakage current Capacitance  Tangent of loss angle	See Table 2	No visible damage Legible marking See detail specification $-20\% < \Delta C/C < +40\%$ of the value measured in 4.12.1 See detail specification
<b>GROUP 3.3</b> 4.13 Characteristics at high and low temperature	D	The capacitors shall be measured at each temperature step Step 1: 20 °C Leakage current Capacitance Tangent of loss angle  Step 2: -55 °C (lower category temperature) Capacitance Tangent of loss angle Step 3: 20 °C Leakage current Capacitance  Tangent of loss angle Step 4: 85 °C Leakage current Capacitance Step 5: upper category temperature Leakage current (with $U_R$ ) Capacitance Tangent of loss angle Step 6: 20 °C Leakage current Capacitance Tangent of loss angle	See Table 2	For use as reference value For use as reference value For use as reference value  See detail specification See detail specification  See detail specification $\Delta C/C \leq \pm 5\%$ of the value measured in Step 1 See detail specification  See detail specification See detail specification  See detail specification See detail specification See detail specification  As in Step 3 As in Step 3 As in Step 3

Table 3 – Tests schedule for qualification approval (continued)

Subclause number and test <sup>a</sup>	D or ND <sup>b</sup>	Conditions of test <sup>a</sup>	Number of specimens ( <i>n</i> ) and number of non-conforming items ( <i>c</i> )	Performance requirements <sup>a</sup>
4.14 Surge  4.14.3 Final measurements	D	Number of cycles: 1 000 Test temperature: ... °C Voltage: 1,15 $U_R$ or 1,15 $U_C$ Protective resistor: 1 000 $\Omega$ Duration of charge: 30 s Duration of no-load: 5 min 30 s  Leakage current Capacitance  Tangent of loss angle	See Table 2	See detail specification $\Delta C/C \leq \pm 10\%$ of the value measured in 4.13 Step 6 See detail specification
<b>GROUP 3.4</b> 4.15 Endurance  4.15.1 Initial measurement 4.15.3 Final measurements	D	Duration: 1 000 h Test temperature: ... °C Voltage: ... V Recovery: 1 h to 2 h  Capacitance Visual examination Leakage current Capacitance  Tangent of loss angle  Equivalent series resistance (if required by the detail specification)	See Table 2	No visible damage Legible marking $\leq 2$ times the value in 4.5.1 $\Delta C/C \leq \pm 20\%$ of the value measured in 4.15.1 $\leq 1,5$ times the value in 4.5.1 See detail specification

**Table 3 – Tests schedule for qualification approval (continued)**

Subclause number and test <sup>a</sup>	D or ND <sup>b</sup>	Conditions of test <sup>a</sup>	Number of specimens ( <i>n</i> ) and number of non-conforming items ( <i>c</i> )	Performance requirements <sup>a</sup>
<b>GROUP 3.5</b> 4.19 Storage at high temperature  4.19.1 Initial measurement 4.19.3 Final measurement	D	Test temperature: upper category temperature Duration: 96 h ± 4 h Recovery: 16 h min Capacitance Visual examination  Leakage current  Capacitance  Tangent of loss angle	See Table 2	No visible damage Legible marking ≤ 5 times the value in 4.5.1 $\Delta C/C \leq \pm 10\%$ of the value measured in 4.19.1 As in 4.5.3
<p><sup>a</sup> Subclause numbers of test and performance requirements refer to Clause 4.</p> <p><sup>b</sup> In this table: D = destructive, ND = non-destructive.</p> <p><sup>c</sup> This test may be carried out on surface mount capacitors mounted on a substrate.</p> <p><sup>d</sup> When different substrate materials are used for the individual subgroup, the detail specification should indicate which substrate material is used in each subgroup.</p>				



### **3.5 Quality conformance inspection**

#### **3.5.1 Formation of inspection lots**

##### **3.5.1.1 Group A and B inspection**

These tests shall be carried out on a lot-by-lot basis.

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

- 1) The inspection lot shall consist of structurally similar capacitors (see 3.2).
- 2a) The sample tested shall representative of the values and the dimensions contained in the inspection lot:
  - in relation to their number;
  - with a minimum of five of any one value.
- 2b) 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.

##### **3.5.1.2 Group C inspection**

These tests shall be carried out on a periodic basis.

Samples shall be representative of the current production of the specified periods and shall be divided into small, medium and large sizes. In order to cover the range of approvals in any period, one voltage shall be tested from each group of sizes. In subsequent periods, other sizes and/or voltage ratings in production shall be tested with the aim of covering the whole range.

#### **3.5.2 The schedule**

The schedule for the lot-by-lot and periodic tests for quality conformance inspection is given in Clause 2, Table 4, of the blank detail specification, for example, IEC 60384-24-1.

#### **3.5.3 Delayed delivery**

When, according to the procedures of IEC 60384-1, 3.10, re-inspection has to be made, solderability and capacitance shall be checked as specified in Group A and B inspection.

#### **3.5.4 Assessment levels**

The assessment level(s) given in the blank detail specification shall preferably be selected from Tables 3a and 3b.

**Table 3a – Lot-by-lot inspection**

Inspection subgroup <sup>d</sup>	EZ		
	<i>IL</i> <sup>a</sup>	<i>n</i> <sup>a</sup>	<i>c</i> <sup>a</sup>
A0	100% <sup>b</sup>		
A1	S-3	<i>c</i>	0
A2	S-3	<i>c</i>	0
B1	S-3	<i>c</i>	0

<sup>a</sup> *IL* = inspection level;  
<sup>a</sup> *n* = sample size;  
<sup>a</sup> *c* = permissible number of non-conforming items.

<sup>b</sup> 100 % testing shall be followed by re-inspection by sampling in order to monitor outgoing quality level by non-conforming items per million (ppm). The sampling level shall be established by the manufacturer. For the calculation of ppm values, any parametric failure shall be counted as a non-conforming item. If one or more non-conforming items occur in a sample, this lot shall be rejected.

<sup>c</sup> Number to be tested: sample size as directly allotted to the code letter for *IL* in Table 2a of IEC 60410 .

<sup>d</sup> The content of the inspection subgroup is described in Clause 2 of the relevant blank detail specification.

**Table 3b – Periodic tests**

Inspection subgroup <sup>b</sup>	EZ		
	<i>p</i> <sup>a</sup>	<i>n</i> <sup>a</sup>	<i>c</i> <sup>a</sup>
C1	3	12	0
C2	3	12	0
C3.1	6	18	0
C3.2	6	12	0
C3.3A	6	12	0
C3.3B	6	12	0
C3.4	3	24	0
C3.5	6	12	0

<sup>a</sup> *p* = periodicity in months;  
<sup>a</sup> *n* = sample size;  
<sup>a</sup> *c* = permissible number of non-conforming items.

<sup>b</sup> The content of the inspection subgroup is described in Clause 2 of the relevant blank detail specification.

#### 4 Test and measurement procedures

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

##### 4.1 Preliminary drying

See IEC 60384-1, 4.3.

## 4.2 Measuring conditions

See IEC 60384-1, 4.2.1.

## 4.3 Mounting

See IEC 60384-1, 4.33.

## 4.4 Visual examination and check of dimensions

See IEC 60384-1, 4.4.

### 4.4.1 Visual examination

Visual examination shall be carried out with suitable equipment with approximately 10× magnification and lighting appropriate to the specimen under test and the quality level required.

NOTE The operator should have available facilities for incident or transmitted illumination as well as an appropriate measuring facility.

### 4.4.2 Requirements

The surface mount capacitors shall be examined to verify that the materials, design, construction, physical dimensions and workmanship are in accordance with the applicable requirements given in the detail specification.

## 4.5 Electrical tests

### 4.5.1 Leakage current

See IEC 60384-1, 4.9, with the following details:

#### 4.5.1.1 Measuring condition

The rated voltage shall be applied across the capacitor and its protective resistor.

The protective resistor shall have a value of 1 000 Ω.

#### 4.5.1.2 Requirements

The leakage current at  $20\text{ °C} \pm 2\text{ °C}$  shall not exceed  $0,1\text{ CU } \mu\text{A}$  ( $\mu\text{F} \times \text{V}$ ) or  $10\text{ } \mu\text{A}$ , whichever is the greater.

### 4.5.2 Capacitance

See IEC 60384-1, 4.7, with the following details:

#### 4.5.2.1 Measuring conditions

The capacitance shall be measured at a frequency of 100 Hz or 120 Hz, as specified in the detail specification. The peak alternating voltage actually applied across the capacitor terminations shall not exceed 0,5 V a.c. r.m.s.

A d.c. bias voltage of

- 1,1 V to 1,5 V for types with a rated voltage of < 2,5 V
  - 2,1 V to 2,5 V for types with a rated voltage of > 2,5 V
- may be applied during the measurement.

The inaccuracy of the measuring instruments shall not exceed  $\pm 2$  % of the specified limit, whether this is given as an absolute value or as a change of capacitance.

NOTE Measurement without a polarizing voltage is optional.

#### **4.5.2.2 Requirements**

The capacitance shall correspond with the rated value taking into account the tolerance.

#### **4.5.3 Tangent of loss angle ( $\tan \delta$ )**

See IEC 60384-1, 4.8.1, with the following details:

##### **4.5.3.1 Measuring conditions**

The measurement shall be made under the conditions of 4.5.2.

The inaccuracy of the measuring equipment shall not exceed 0,01 in absolute value.

##### **4.5.3.2 Requirements**

The tangent of loss angle (at 20 °C) shall meet the requirements of the detail specification.

#### **4.5.4 Equivalent series resistance (ESR)**

See IEC 60384-1, 4.8.2, with the following details:

##### **4.5.4.1 Measuring condition**

The ambient temperature shall be 20 °C  $\pm$  2 °C.

The peak a.c. value of the measuring voltage shall not exceed 0.5 V r.m.s.

The frequency of measuring voltage shall be 100 kHz.

The error of measurement shall not exceed  $\pm 5\%$  of the requirement, or 0,02  $\Omega$ , whichever is the greater.

##### **4.5.4.2 Requirements**

The equivalent series resistance (ESR) shall meet the requirements of the detail specification.

#### **4.6 Resistance to soldering heat**

Unless otherwise specified in the relevant specification, IEC 60068-2-58 shall be applied.

##### **4.6.1 Initial measurement**

The capacitance shall be measured according to 4.5.2.

##### **4.6.2 Test**

Unless otherwise specified in the relevant specification, IEC 60068-2-58 shall be applied.