

INTERNATIONAL STANDARD

IEC
60384-25

First edition
2006-06

Fixed capacitors for use in electronic equipment –

Part 25:

Sectional specification –

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

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Fixed capacitors for use in electronic equipment –

Part 25: Sectional specification – Surface mount fixed aluminium electrolytic capacitors with conductive polymer solid electrolyte

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –**Part 25: Sectional specification – Surface mount fixed aluminium electrolytic capacitors with conductive polymer solid electrolyte**

FOREWORD

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- 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 60384-25 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
40/1733/FDIS	40/1756/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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FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 25: Sectional specification – Surface mount fixed aluminium electrolytic capacitors with conductive polymer solid electrolyte

1 General

1.1 Scope

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

Fixed aluminium electrolytic chip capacitors with solid (MnO_2) are not included but are covered by IEC 60384-18.

1.2 Object

The object of this standard is to prescribe preferred ratings and characteristics and to select from IEC 60384-1:1999, 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 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 60068-2-58:2004, *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 surface mount 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.

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 2.4 of IEC 60384-1 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 ---);
- 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.

2.2 Preferred values of ratings

2.2.1 Rated capacitance (C_R)

The rated capacitance shall be expressed in microfarads (μF).

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

2.2.2 Tolerance on rated capacitance

Preferred values of tolerance on rated capacitance are: $\pm 10\%$ and $\pm 20\%$.

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 Surge voltage

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

Table 1 – Surge voltage

Rated voltage V	2,0	2,5	4,0	5,0	6,3	8,0	10	12,5	16	20	25
Surge voltage V	2,3	2,9	4,6	5,8	7,2	9,2	12	14	18	23	29

2.2.5 Rated temperature

The value of the rated temperature is +105 °C and +125 °C.

3 Quality assessment procedures

3.1 Primary stage of manufacture

The primary stage of manufacture is the capacitor manufacturer's evaluation of the formed anode foil.

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 of 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 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 give 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 do not exceed the specified number of permissible non-conforming items for each group or subgroup and the total number of permissible non-conformances.

Approval is granted when the number of non-conforming items do 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 non-conforming items for the different tests or groups of tests. Table 3 together with the details of the 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 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.

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

Group No.	Test	Subclause of this publication	Number of specimens n^d	Permissible number of non-conforming items			
0	High surge current ^b	4.20	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 (ESR)	4.5.4					
	Spare specimens						
1A	Resistance to soldering heat	4.6	12	0			
	Component solvent resistance ^b	4.18					
1B	Solderability	4.7	12	0			
	Solvent resistance of the marking ^b	4.19					
2	Substrate bending test	4.9	12	0			
3 ^a	Mounting	4.3	84	0 ^c			
	Visual examination	4.4					
	Leakage current	4.5.1					
	Capacitance	4.5.2					
	Tangent of loss angle	4.5.3					
	Equivalent series resistance (ESR)	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			
	Charge and discharge ^b	4.17					
3.4	Endurance	4.15	36	0			
3.5	Storage at high temperature	4.16	12	0			
	Surge	4.14					
^a	The values of these measurements serve as initial measurements for the tests of subgroup 3.						
^b	If required in the detail specification.						
^c	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.						
^d	For case size/voltage combinations, see 3.4.1.						

Table 3 – Tests schedule for qualification approval

Subclause number and test ^a	D or ND ^b	Conditions of test ^a	Number of specimens (<i>n</i>) and number of non-conforming items (<i>c</i>)	Performance requirements ^a
GROUP 0	ND		See Table 2	
4.20 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 ($\tan \delta$)		Frequency: 120 Hz		As in 4.5.3.3
4.5.4 Equivalent series resistance (ESR)		Frequency: 100 kHz		As in 4.5.4
GROUP 1A	D		See Table 2	
4.6 Resistance to soldering heat				
4.6.1 Initial measurement		Capacitance (the value obtained in Group 3 may be used)		
4.6.2 Test		Method: ... Deflection: ...s Reflow profile: ... Recovery: 24 h ± 2 h		
4.6.3 Final measurement		Visual examination Leakage current Capacitance Tangent of loss angle ($\tan \delta$) Equivalent series resistance (ESR)		As in 4.6.3 As in 4.5.1 See detail specification As in 4.5.3 See detail specification
4.18 Component solvent resistance (if required in the detail specification)		Solvent: ... Solvent temperature: ... Method 2 Recovery: ...		See detail specification

Table 3 – Tests schedule for qualification approval (continued)

Subclause number and test ^a	D or ND ^b	Conditions of test ^a	Number of specimens (<i>n</i>) and number of non-conform- ing items (<i>c</i>)	Performance requirements ^a
GROUP 1B 4.7 Solderability 4.7.2 Final measurement 4.19 Solvent resistance of the marking ^c (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
GROUP 2 4.9 Substrate bending test 4.9.1 Initial measurement 4.9.3 Final inspection	D	Deflection: ... Capacitance Visual examination Capacitance (with printed board in bent position)	See Table 2	No visible damage See detail specification
GROUP 3 4.3 Mounting 4.3.1 Initial measurement 4.3.3 Final inspection	D	Substrate material: ... ^d Capacitance Visual examination Leakage current Capacitance Tangent of loss angle ($\tan \delta$) Equivalent series resistance (ESR)	See Table 2	No visible damage As in 4.5.1 See detail specification As in 4.5.3 See detail specification

Table 3 – Tests schedule for qualification approval (continued)

Subclause number and test ^a	D or ND ^b	Conditions of test ^a	Number of specimens (<i>n</i>) and number of non-conforming items (<i>c</i>)	Performance requirements ^a
GROUP 3.1	D		See Table 2	
4.8 Shear test		Visual examination		No visible damage
4.10 Rapid change of temperature				
4.10.1 Initial measurement		Capacitance (the value obtained in Group 3 may be used)		
4.10.2 Test		T_A = Lower category temperature T_B = Upper category temperature Five cycles Duration t_1 = 30 min Recovery: 1 h to 2 h		
4.10.3 Final measurements		Leakage current Capacitance Tangent of loss angle		As in 4.5.1 $\Delta C/C \leq \pm 10\%$ of value measured in 4.10.1 As in 4.5.3
4.11 Climatic sequence				
4.11.1 Initial measurement		Capacitance		
4.11.2 Dry heat		Temperature: upper category temperature Duration: 16 h		
4.11.3 Damp heat, cyclic, test Db, first cycle				
4.11.4 Cold		Temperature: lower category temperature Duration: 2h		
4.11.5 Damp heat, cyclic, test Db, remaining cycles		Recovery: 1 h to 2 h		
4.11.6 Final measurements		Visual examination Leakage current Capacitance Tangent of loss angle		No visible damage Legible marking As in 4.5.1 $\Delta C/C \leq \pm 20\%$ of value measured in 4.11.1 $\leq 1,5$ times the limit of initial limit

Table 3 – Tests schedule for qualification approval (continued)

Subclause number and test ^a	D or ND ^b	Conditions of test ^a	Number of specimens (<i>n</i>) and number of non-conforming items (<i>c</i>)	Performance requirements ^a
<p>GROUP 3.2</p> <p>4.12 Damp heat, steady state</p> <p>4.12.1 Initial measurement</p> <p>4.12.3 Final measurements</p>	D	<p>Recovery: 1 h to 2 h</p> <p>Duration: 21 days</p> <p>Capacitance</p> <p>Visual examination</p> <p>Leakage current</p> <p>Capacitance</p> <p>Tangent of loss angle</p>	See Table 2	<p>No visible damage</p> <p>Legible marking</p> <p>5 times initial limit</p> <p>See detail specification</p> <p>≤ 1,5 times the limit of initial limit</p>
<p>GROUP 3.3</p> <p>4.13 Characteristics at high and low temperature</p>	D	<p>The capacitors shall be measured at each temperature step</p> <p>Step 1: 20 °C</p> <p>Capacitance (if applicable)</p> <p>Impedance</p> <p>Step 2: lower category temperature</p> <p>Capacitance (if applicable)</p> <p>Impedance</p> <p>Tangent of loss angle (if applicable)</p> <p>Step 3: upper category temperature</p> <p>Leakage current</p> <p>Capacitance (if applicable)</p> <p>Tangent of loss angle (if applicable)</p>	See Table 2	<p>For use as reference value</p> <p>For use as reference value</p> <p>$\Delta C/C \leq \pm 20\%$ of value measured in Step 1</p> <p>Ratio with respect to value in Step 1: ≤ 1,5 times</p> <p>≤ 2 times the limit of 4.5.3.2</p> <p>At 105 °C (with U_R) :</p> <p>≤ 12,5 times the limit of 4.5.1</p> <p>$\Delta C/C \leq \pm 20\%$</p> <p>At $U_R \leq 4$:</p> <p>≤ 3 times the limit of 4.5.3</p> <p>At $U_R > 4$:</p> <p>≤ 2 times the limit of 4.5.3</p>

Table 3 – Tests schedule for qualification approval (continued)

Subclause number and test	D or NDb	Conditions of test	Number of specimens (n) and number of non-conforming items (c)	Performance requirementsa
4.17 Charge and discharge (if required in the detail specification) 4.17.1 Initial measurement 4.17.2 Test 4.17.3 Final measurements	D	Capacitance Temperature: ... °C Number of cycles: 10 ⁶ Duration of charge: 0,5 s Duration of discharge: 0,5 s Visual examination Leakage current Capacitance Tangent of loss angle Equivalent series resistance	See Table 2	No visible damage Legible marking As in 4.5.1 $\Delta C/C \leq \pm 20\%$ of value measured in 4.17.1 $\leq 1,5$ times the limit specified in 4.5.3.2 ≤ 2 times the limit specified in 4.5.4.2
GROUP 3.4 4.15 Endurance 4.15.1 Initial measurement 4.15.2 Test 4.15.3 Final measurements	D	Capacitance Duration: 1 000 h Test temperature: ... °C Voltage: ... V Recovery: 1 h to 2 h Visual examination Leakage current Capacitance Tangent of loss angle Equivalent series resistance	See Table 2	No visible damage Legible marking ≤ 2 times the limit specified in 4.5.1.2 $\Delta C/C \leq \pm 20\%$ of value measured in 4.15.1 $\leq 1,5$ times the limit specified in 4.5.3.2 ≤ 2 times the limit specified in 4.5.4.2

Table 3 – Tests schedule for qualification approval (continued)

Subclause number and test ^a	D or ND ^b	Conditions of test ^a	Number of specimens (<i>n</i>) and number of non-conforming items (<i>c</i>)	Performance requirements ^a
<p>GROUP 3.5</p> <p>4.16 Storage at high temperature</p> <p>4.16.1 Initial measurement</p> <p>4.16.2 Test</p> <p>4.16.3 Final measurements</p> <p>4.14 Surge</p> <p>4.14.1 Initial measurement</p> <p>4.14.2 Test</p> <p>4.14.3 Final measurements</p>	<p>D</p>	<p>Capacitance (the value obtained in Group 3 may be used)</p> <p>Test temperature: upper category temperature</p> <p>Duration: 96 h ± 4 h</p> <p>Recovery: 16 h min.</p> <p>Visual examination</p> <p>Leakage current</p> <p>Capacitance</p> <p>Tangent of loss angle</p> <p>Capacitance</p> <p>Number of cycles: 1 000</p> <p>Test temperature: ... °C</p> <p>Voltage: 1,15 U_R or 1,15 U_C</p> <p>Protective resistor: 1 000 Ω</p> <p>Duration of charge: 30 s</p> <p>Duration of no load: 5 min 30 s</p> <p>Visual examination</p> <p>Leakage current</p> <p>Capacitance</p> <p>Tangent of loss angle</p>	<p>See Table 2</p>	<p>No visible damage</p> <p>Legible marking</p> <p>< 2 times the limit specified in 4.5.1</p> <p>$\Delta C/C \leq \pm 10\%$ of the value measured in 4.17.1</p> <p>As in 4.5.3</p> <p>No visible damage</p> <p>As in 4.5.1</p> <p>$\Delta C/C \leq \pm 15\%$ of the value measured in 4.14.1</p> <p>$\leq 1,5$ times the limit specified in 4.5.3.2</p>
<p>^a Subclause numbers of test and performance requirements refer to Clause 4.</p> <p>^b In this table: D = destructive, ND = non-destructive.</p> <p>^c This test may be carried out on surface mount capacitors mounted on a substrate.</p> <p>^d 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 be 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 60384-25-1.

3.5.3 Delayed delivery

When, according to the procedures of IEC 60384-1, 3.10, re-inspection has to be made, solderability, capacitance and leakage current 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	EZ		
	<i>IL</i> ^a	<i>n</i> ^a	<i>c</i> ^a
A0	100 % ^b		
A1	S – 3	<i>c</i>	0
A2	S – 3	<i>c</i>	0
B1	S – 3	<i>c</i>	0

^a *IL* = inspection level;
n = sample size;
c = permissible number of non-conforming items.

^b 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.

^c Number to be tested: sample size as directly allotted to the code letter for *IL* in Table IA of IEC 60410 .

^d The content of the inspection subgroup is described in Clause 2 of the relevant blank detail specification.

Table 3b – Periodic test

Inspection subgroup ^b	EZ		
	<i>p</i> ^a	<i>n</i> ^a	<i>c</i> ^a
C1	3	12	0
C2	3	12	0
C3.1	6	12	0
C3.2	6	24	0
C3.3A	6	12	0
C3.3B	6	12	0
C3.4	3	36	0
C3.5	6	12	0

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

^b 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, with the following details:

4.3.1 Initial measurement

The capacitance shall be measured according to 4.5.2.

4.3.2 Test

- a) The capacitor shall be mounting by reflow soldering.
- b) Reflow temperature profile of the detail specification.

4.4 Visual examination and check of dimensions

See IEC 60384-1, 4.4, with the following details:

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 conditions

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 $0,2\text{ CU } \mu\text{A}$ or $500\text{ } \mu\text{A}$, whichever is the greater.

When the measurement value exceeds the regulation value, the next pre-conditioning is done and measured.

NOTE Pre-conditioning:

The capacitor should be serially attached to a protective resistor ranging from $10\text{ } \Omega$ to $1\text{ }000\text{ } \Omega$ and d.c. voltage equivalent to the rated voltage should be applied for 2 h at $105\text{ °C} \pm 2\text{ °C}$.

The capacitor has become equal to the rated voltage with a tolerance of $\pm 3\%$.

Next, after letting the capacitor cool to room temperature, it should be discharged through a resistor of approximately $1\text{ } \Omega/\text{V}$ and then stored at standard atmospheric conditions for 12 h to 24 h.

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 120 Hz, as specified in the detail specification. The peak alternating voltage actually applied across the capacitor terminations shall not exceed $0,5\text{ V a.c. r.m.s.}$

A d.c. bias voltage of

- 1,1 V to 1,5 V for types with a rated voltage of $\leq 2,5\text{ V}$
- 2,1 V to 2,5 V for types with a rated voltage of $> 2,5\text{ V}$

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 d.c. 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 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 conditions

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

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 $100\text{ kHz} \pm 10\text{ kHz}$.

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.

4.5.5 Impedance (if applicable)

See IEC 60384-1, 4.10, with the following details:

4.5.5.1 Initial measurement

The frequency of measurement: $120\text{ Hz} \pm 10\%$.

To demonstrate that the voltage is sufficiently small, it shall be applied to one of the capacitors in each sample for 1 min during which time there shall be no readable change in the impedance of the capacitor.

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

4.5.5.2 Requirements

The impedance 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.

4.6.3 Final inspection, measurements and requirements

After recovery, the surface mount capacitors shall be visually examined and measured and shall meet the following requirements.