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QC 301300

Second edition
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Fixed capacitors for use in electronic equipment –

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

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

FOREWORD

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International Standard IEC 60384-17 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 1987 and constitutes minor revisions related to tables, figures and references.

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

FDIS	Report on voting
40/1597/FDIS	40/1630/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 (new) 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 3000 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 sulfide film dielectric chip d.c. capacitors

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

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

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 (under consideration)

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

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 QC 301300 number that appears on the front cover of this publication is the specification number in the IECQ Quality Assessment System for Electronic Components.

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.

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

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

1 General

1.1 Scope

This part of IEC 60384 applies to fixed capacitors with metallized electrodes and polypropylene dielectric for use in electronic equipment.

NOTE Capacitors which have mixed foil and metallized electrodes are also within the scope of this standard.

These capacitors may have "self-healing" properties depending on conditions of use.

Capacitors covered by this specification are mainly intended for use with alternating voltage and/or for pulse applications. The maximum reactive power applicable is 10 000 var and the maximum peak voltage is 3 000 V.

Capacitors for reactive power exceeding 500 var and to which a maximum peak voltage of 2 500 V at 50 Hz can be applied are not covered by this standard, except when they are the highest part of a range of reactive power mainly situated below 500 var at 50 Hz.

This standard is not intended to cover capacitance values higher than 20 μF.

Two performance grades of capacitors are covered, Grade 1 for long-life application and Grade 2 for general application.

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

Capacitors for electrical shock hazard protection (covered by IEC 60065) and fluorescent lamp and motor capacitors (covered by IEC technical committee 33, and IEC technical committee 34) are also excluded.

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 an 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, E*nvironmental testing – Part 1: General and guidance*

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

IEC 60384-17-1, *Fixed capacitors for use in electronic equipment – Part 17: Blank detail specification: Fixed metallized polypropylene film dielectric a.c. and pulse capacitors. Assessment level E*

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

ISO 3, *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 capacitor as an aid to easy recognition and for comparison of the capacitor with others. Dimensions and their associated tolerances, which affect interchangeability and mounting, shall be given in the detail specification. All dimensions shall preferably be stated in millimetres.

Normally, the numerical values shall be given for the length of the body, the width and height of the body and the wire spacing, or for cylindrical types, the body diameter, and the length and diameter of the terminations. When necessary, for example when a number of items (capacitance values/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 capacitor. When the capacitor is not designed for use on printed boards, this shall be clearly stated in the detail specification

1.4.2 Mounting

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

1.4.3 Ratings and characteristics

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

1.4.3.1 Rated capacitance range

See 2.2.1.

NOTE When products approved to the detail specification have different ranges, the following statement should be added:

"The range of values available in each voltage range is given in IEC QC 001005."

1.4.3.2 Sinusoidal current (if applicable)

The detail specification shall state the derating curve of the sinusoidal current versus temperature with reference to 70 °C, and the derating curve of the sinusoidal current versus frequency and of the sinusoidal current versus capacitance.

1.4.3.3 Particular characteristics

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

1.4.3.4 Soldering

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

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 and the following apply.

1.5.1

Performance grades

1.5.1.1

performance grade 1 capacitors (long-life)
capacitors intended for long-life applications with stringent requirements for the electrical parameters

1.5.1.2

performance grade 2 capacitors (general purpose)
capacitors for general application where the stringent requirements of performance grade 1 are not necessary

1.5.2

stability grade
capacitance drift after climatic and mechanical tests and after endurance tests.

NOTE The performance grade and the stability grade must be noted in the detail specification

1.5.3

performance grade and stability grade combinations (if stability grade is required for a.c. and pulse capacitors)
see the table below for preferred values:

Table 1 – Preferred values

Performance grades	Stability grades	Combination designations
1	1	1.1
	2	1.2
2	–	2

The three combinations concern capacitance stability and tan δ values. Distinction in performance of the three combinations is shown in Table 4.

1.5.4
rated voltages

NOTE The sum of the d.c. voltage and the peak a.c. voltage or the peak pulse voltage applied to the capacitor must not exceed the rated voltage. The value of the peak a.c. voltage allowed at different frequencies is under consideration.

1.5.4.1
rated d.c. voltage

maximum d.c. voltage which may be applied continuously to a capacitor at the rated temperature

1.5.4.2
rated a.c. voltage

maximum r.m.s. alternating voltage which may be applied continuously to a capacitor at the rated temperature and at a given frequency

1.5.4.3
rated pulse voltage

peak value of the pulse voltage which may be applied continuously to a capacitor at the rated temperature and at a given frequency

1.5.5
rated voltage pulse slope $\frac{(\mathrm{d}U)}{(\mathrm{d}t)_\mathrm{R}}$ (if applicable)

maximum admissible value of the voltage slope $\frac{\mathrm{d}U}{\mathrm{d}t}$ of a pulse, at the rated temperature at such a repetition frequency that no significant increase of temperature occurs

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) rated capacitance;

b) rated a.c. and/or pulse voltage (a.c. voltage may be indicated by the symbol ~) and the corresponding frequency if different from 50 Hz;

c) tolerance on rated capacitance;

d) rated voltage pulse slope (if applicable);

e) rated current and corresponding frequency (if applicable);

f) year and month (or week) of manufacture;

g) manufacturer's name or trade mark;

h) climatic category;

i) manufacturer's type designation;

j) reference to the detail specification.

1.6.2 The capacitor shall be clearly marked with a), b) and c) above and with as many as possible of the remaining items as is considered necessary. Any duplication of information in the marking on the capacitor should be avoided.

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

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

2 Preferred ratings and characteristics

2.1 Preferred characteristics

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

2.1.1 Preferred climatic categories

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

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

Lower category temperature:	–55 °C, –40 °C, –25 °C and –10 °C
Upper category temperature:	+70 °C, +85 °C; +100 °C and +105 °C
Duration of the damp heat, steady state test:	4, 10, 21 and 56 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)

Preferred values of rated capacitance are values chosen from the E series of preferred values given in IEC 60063.

2.2.2 Tolerances on rated capacitance

The preferred tolerances on the rated capacitance are ±20 %; ±10 %; ±5 %; ±2 %; ±1 %.

2.2.3 Rated capacitance with associated tolerance values

For preferred combinations of capacitance series and tolerances see the table below:

Table 2 – Preferred combinations

Preferred combinations	
Series	**Tolerances**
E 6	±20 %
E 12	±10 %
E 24	±5 %
E 48	±2 %
E 96	±1 %

2.2.4 Rated a.c. voltage ($U_{Ra.c.}$ or $U_{R\sim}$)

The frequency for the rated a.c. voltage shall be 50/60 Hz unless the detail specification prescribes a higher frequency.

The preferred values of rated a.c. voltage (r.m.s. value) shall be chosen from the R10 or R20 series given in ISO 3.

The detail specification shall give the derating curve of the admissible r.m.s. voltage versus temperature (higher than rated temperature) and, if applicable, versus frequency.

2.2.5 Category a.c. voltage ($U_{Ca.c.}$ or $U_{C\sim}$)

The category a.c. voltage is equal to the rated a.c. voltage $U_{Ra.c.}$ for upper category temperatures up to 85 °C. For an upper category temperature >85 °C the category a.c. voltage is 0,7 $U_{R\sim}$.

2.2.6 Rated temperature

The standard value for rated temperature is 85 °C. Except for upper category temperature of 70 °C, the rated temperature is 70 °C.

NOTE AC rated temperature is 15 °C less than d.c. rated temperature.

2.2.7 Rated a.c. current (when required in the detail specification)

The detail specification shall state:

- the frequency
- the r.m.s. value of the rated a.c. current applicable at the specified frequency (value chosen from R10 or R20 series)
- the derating curve of the admissible a.c. current versus ambient temperature.

3 Quality assessment procedures

3.1 Primary stage of manufacture

The primary stage of manufacture is the winding of the capacitor element or the equivalent operation.

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 Certified records of released lots

The information required in IEC 60384-1, 3.9, shall be made available when prescribed in the detail specification and when requested by a purchaser. After the endurance test the parameters for which variables information is required are the capacitance change, tan δ. The insulation resistance is only required by attribute.

3.4 Qualification approval

The procedures for qualification approval testing are given in the generic specification 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 below.

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

3.4.1.1 Sampling

The fixed sample size procedure is described in IEC 60384-1, 3.5.3 b). 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.

The sample shall consist of specimens having the lowest and highest voltages, and for these voltages the lowest and highest capacitances. 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). When the range consists of less than four values, the number of specimens to be tested shall be that required for four values.

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 3 gives the number of samples to be tested in each group or subgroup together with the permissible number of defectives for qualification approval tests.

3.4.1.2 Tests

The complete series of tests specified in Tables 3 and 4 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.

Specimens found defective during the tests of Group 0 shall not be used for the other groups.

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

The approval is granted when the number of defectives does not exceed the specified number of permissible defectives for each group or subgroup and the total number of permissible defectives.

NOTE Tables 3 and 4 together form the fixed sample size test schedule, for which Table 3 includes the details for the sampling and permissible defectives for the different tests or groups of tests, whereas Table 4 together with the details of tests 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 must be identical to those prescribed in the detail specification for quality conformance inspection.

Table 3 – Sampling plan together with numbers of permissible defectives for qualification approval tests for a.c. and pulse capacitors

Group No.	**Test**	**Subclause of this publication**	**Number of specimens (n) and number of non-conformances (c)**						
			Per value[c]	**For four or less values to be tested**[c]			**For six values to be tested**[c]		
			n	4 n	c	c total	6 n	c	c total
0	Visual examination	4.1							
	Marking	1.6							
	Dimensions	4.1							
	Capacitance	4.2.2	29	116	2[b]		174	3[b]	
	Tangent of loss angle	4.2.3							
	Voltage proof	4.2.1	(+5)[e]	(+20)[e]			(+30)[e]		
	Insulation resistance	4.2.4	(+5)[e]	(+20)[e]			(+30)[e]		
	Inductance[e]	4.2.5							
	Sealing[e]								
	Spare specimens		2	8			12		
1A	Robustness of terminations	4.3	3	12	1	4	18	1	6
	Resistance to soldering heat	4.4							
	Component solvent resistance	4.14							
1B	Solderability	4.5	6	24	1		36	2[b]	
	Solvent resistance of the marking	4.15							
	Rapid change of temperature	4.6							
	Vibration	4.7							
	Bump or shock[a]	4.8 or 4.9							
1	Climatic sequence	4.10	9	36	2		54	3	
2	Damp heat, steady state	4.11	5	20	1		30	2[b]	
3	Endurance test at 50 Hz/60 HZ alternating voltage	4.12.1	10	40	3[b]		60	4[b]	
	Endurance test with sinusoidal current or voltage[e]	4.12.2	5	20	1[b]		30	2[b]	
	Pulse endurance test[e]	4.12.3	5	20	1[b]		30	2[b]	
4	Temperature characteristics[e]	4,2,6	5	20	1		30	2	
	Charge and discharge[d]	4.13							

[a] As required in the detail specification.

[b] Not more than one defective is permitted from any one value.

[c] Capacitance-voltage combinations, see 3.4.1.

[d] Not required when pulse endurance test is required.

[e] If required in the detail specification.

Table 4 – Test schedule for qualification approval

Subclause number and test[a]	D or ND [b]	Conditions of test[a]	Number of specimens (n) and number of permissible non-conformances (c)	Performance requirements[a]
Group 0	ND		See Table 3	
4.1 Visual examination				As in 4.1 Legible marking and as specified in the detail specification
4.1 Dimensions (detail)				See detail specification
4.2.2 Capacitance				Within specified tolerance
4.2.3 Tangent of loss angle (tan δ)		Frequency: 1 kHz		As in 4.2.3.2
4.2.1 Voltage proof		See detail specification for the method		No breakdown or flashover
4.2.4 Insulation resistance		See detail specification for for the method		As in 4.2.4.2
4.2.5 Inductance (if applicable)				Inductance: ≤... mH (see detail specification)
Sealing (if applicable)		See detail specification for the method		No seepage of impregnant or harmful deformation of the case
Group 1A	D		See Table 3	
4.3.1 Initial measurements		Capacitance Tangent of loss angle: For $C_R > 1$ µF: at 1 kHz $C_R \leq 1$ µF: at 10 kHz		
4.3 Robustness of terminations		Visual examination		No visible damage
4.4 Resistance to soldering heat		No pre-drying See detail specification for the method (1A or 1B)		
4.14 Component solvent resistance (if applicable)		Solvent: ... Solvent temperature: ... Method 2 Recovery: ...		See detail specification
4.4.2 Final measurements		Visual examination		No visible damage Legible marking
		Capacitance		$\Delta C/C$ for Grade 1.1: ≤1 % Grade 1.2: ≤2 % Grade 2: ≤3 % of value measured in 4.3.1
		Tangent of loss angle		Increase of tan δ for $C \leq 1$ µF: for Grade 1.1: ≤0,001 Grade 1.2: ≤0,002 Grade 2: ≤0,004 for $C > 1$ µF: see detail specification, compared to values measured in 4.3.1

Table 4 *(continued)*

Subclause number and test[a]	D or ND [b]	Conditions of test[a]	Number of specimens (n) and number of permissible non-conformances (c)	Performance requirements[a]
Group 1B	D		See Table 3	
4.5 Solderability		Without ageing See detail specification for the method	↓	Good tinning as evidenced by free flowing of the solder with wetting of the terminations or solder shall flow within . . . s, as applicable
4.15 Solvent resistance of the marking (if applicable)		Solvent: ... Solvent temperature: ... Method 1 Rubbing material: cotton wool Recovery: ...		Legible marking
4.6.1 Initial measurements		Capacitance Tangent of loss angle: For $C_R > 1$ µF: at 1 kHz $C_R \le 1$ µF: at 10 kHz		
4.6 Rapid change of temperature		T_A = Lower category temperature T_B = Upper category temperature Five cycles Duration t = 30 min Visual examination		No visible damage
4.7 Vibration		For mounting method see detail specification Procedure B4 Frequency range: from . . . Hz to . . . Hz Amplitude: 0,75 mm or acceleration 98 m/s^2 (whichever is the less severe) Total duration: 6 h		
4.7.2 Final inspection		Visual examination		No visible damage
4.8 Bump (or shock, see 4.9)		For mounting method see detail specification Number of bumps: ... Acceleration: ... m/s^2 Duration of pulse: ... ms		
4.9 Shock (or bump, see 4.8)		For mounting method see detail specification Number of bumps: ... Acceleration: ... m/s^2 Duration of pulse: ... ms		
4.8.3 or 4.9.3 Final measurements		Visual examination		No visible damage
		Capacitance		$\Delta C/C$ for Grade 1.1: ≤1 % Grade 1.2: ≤2 % Grade 2: ≤3 % of value measured in 4.6.1
		Tangent of loss angle		Increase of tan δ: for $C \le 1$ µF: for Grade 1.1: ≤0,001 Grade 1.2: ≤0,002 Grade 2: ≤0,004 for $C > 1$ µF: see detail specification, compared to values measured in 4.6.1
		Insulation resistance		≥50 % of values in 4.2.4.2

Table 4 *(continued)*

Subclause number and test[a]	D or ND[b]	Conditions of test[a]	Number of specimens (n) and number of permissible non-conformances (c)	Performance requirements[a]
Group 1	D		See Table 3 ↓	
4.10 Climatic sequence				
4.10.2 Dry heat		Temperature: upper category temperature Duration: 16 h		
4.10.3 Damp heat, cyclic, Test Db, first cycle				
4.10.4 Cold		Temperature: lower category temperature Duration: 2 h		
4.10.5 Low air pressure (if required by the detail specification)		Air pressure: 8 kPa		
4.10.5.3 Final measurement		Visual examination		No permanent breakdown, flashover or harmful deformation of the case
4.10.6 Damp heat, cyclic, Test Db, remaining cycles				
4.10.6.2 Final measurement		Visual examination		No visible damage Legible marking
		Capacitance		$\Delta C/C$ for Grade 1.1: ≤1 % Grade 1.2: ≤3 % Grade 2: ≤5 % of value measured in 4.4.2, 4.8.3 or 4.9.3 as applicable
		Tangent of loss angle		Increase of tan δ: for $C \leq 1$ µF: for Grade 1.1: ≤0,0015 Grade 1.2: ≤0,003 Grade 2: ≤0,005 for $C > 1$ µF: see detail specification, compared to values measured in 4.3.1 or 4.6.1 as applicable
		Insulation resistance	↓	≥50 % of values in 4.2.4.2
Group 2	D		See Table 3 ↓	
4.11 Damp heat, steady state				
4.11.1 Initial measurements		Capacitance Tangent of loss angle at 1 kHz		
4.11.3 Final measurements		Visual examination		No visible damage Legible marking
		Capacitance	↓	$\Delta C/C$ for Grade 1.1: ≤1 % Grade 1.2: ≤3 % Grade 2: ≤5 % of value measured in 4.11.1

Table 4 *(continued)*

Subclause number and test[a]	D or ND [b]	Conditions of test[a]	Number of specimens (n) and number of permissible non-conformances (c)	Performance requirements[a]
Group 2 *(continued)*			See Table 3	
		Tangent of loss angle		Increase of tan δ: for $C \leq 1$ µF: for Grade 1: ≤0,001 Grade 2: ≤0,002 for $C > 1$ µF: see detail specification, compared to values measured in 4.11.1
		Insulation resistance		≥50 % of values in 4.2.4.2
Group 3A	D		See Table 3	
4.12.1 Endurance test at 50/60 Hz alternating voltage (if applicable)		Duration: Grade 1: 2 000 h Grade 2: 1 000 h		
4.12.1.1 Initial measurements		Capacitance		
		Tangent of loss angle For $C_R > 1$ µF: at 1 kHz $C_R \leq 1$ µF: at 10 kHz		
4.12.1.3 Final measurements		Visual examination		No visible damage Legible marking
		Capacitance		$\Delta C/C$ for Grade 1: ≤5 % Grade 2: ≤10 % of value measured in 4.12.1.1
		Tangent of loss angle		Increase of tan δ: for $C \leq 1$ µF: for Grade 1: ≤0,0015 Grade 2: ≤0,003 for $C > 1$ µF: see detail specification, compared to values measured in 4.12.1.1
		Insulation resistance		≥50 % of values in 4.2.4.2
Group 3B [c]	D		See Table 3	
4.12.2 Endurance test with sinusoidal current or voltage (if applicable)		Duration: Grade 1: 2 000 h Grade 2: 1 000 h Frequency:... Hz		
4.12.2.1 Initial measurements		Capacitance		
		Tangent of loss angle For $C_R > 1$ µF: at 1 kHz $C_R \leq 1$ µF: at 10 kHz		
4.12.2.3 Final measurements		Visual examination		No visible damage Legible marking
		Capacitance		$\Delta C/C$ for Grade 1: ≤5 % Grade 2: ≤10 % of value measured in 4.12.2.1

Table 4 *(continued)*

Subclause number and test[a]	**D or ND** [b]	**Conditions of test**[a]	**Number of specimens (n) and number of permissible non-conformances (c)**	**Performance requirements**[a]
Group 3B [c] *(continued)*			See Table 3	
		Tangent of loss angle	↓	Increase of tan δ: for $C \leq 1$ µF: for Grade 1: ≤0,0015 Grade 2: ≤0,003 for $C > 1$ µF: see detail specification, compared to values measured in 4.12.2.1
		Insulation resistance		≥50 % of values in 4.2.4.2
Group 3C [c]	D		See Table 3	
4.12.3 Pulse endurance test (if applicable)		Duration: Grade 1: 2 000 h Grade 2: 1 000 h Pulse repetition rate: ... Hz Discharge time constant: as in 4.12.3.2 Applied peak voltage: equal to the rated peak voltage (see detail specification)	↓	
4.12.3.1 Initial measurements		Capacitance Tangent of loss angle: For $C_R > 1$ µF: at 1 kHz $C_R \leq 1$ µF: at 10 kHz		
4.12.3.3 Final measurements		Visual examination		No visible damage Legible marking
		Capacitance		ΔC/C for Grade 1: ≤5 % Grade 2: ≤10 % of value measured in 4.12.3.1
		Tangent of loss angle		Increase of tan δ: for $C \leq 1$ µF: for Grade 1: ≤0,0015 Grade 2: ≤0,003 for $C > 1$ µF: see detail specification, compared to values measured in 4.12.3.1
		Insulation resistance		≥50 % of values in 4.2.4.2
Group 4	D		See Table 3	
4.2.6 Characteristics depending on temperature (if applicable)		Capacitance	↓	As in 4.2.6
		Insulation resistance		As in 4.2.6
4.13 Charge and discharge (not applicable when pulse endurance test is required)				

Table 4 *(continued)*

Subclause number and test[a]	D or ND [b]	Conditions of test[a]	Number of specimens (n) and number of permissible non-conformances (c)	Performance requirements[a]
Group 4 *(continued)*				
4.13.1 Initial measurements		Capacitance Tangent of loss angle: for C_R > 1 µF: at 1 kHz C_R ≤ 1 µF: at 10 kHz Duration of charge: . . . s Duration of discharge: . . . s	See Table 3 ↓	
4.13.3 Final measurements		Capacitance		*ΔC/C* for Grade 1.1: ≤1 % Grade 1.2: ≤3 % Grade 2: ≤5 % of value measured in 4.13.1
		Tangent of loss angle		Increase of tan *δ*: for C ≤ 1 µF: for Grade 1: ≤0,003 Grade 2: ≤0,005 for C > 1 µF: see detail specification, compared to values measured in 4.13.1
		Insulation resistance		≥50 % of values in 4.2.4.2

[a] Subclause numbers of test and performance requirements refer to Clause 4 of this specification.

[b] In this table: D = destructive ; ND = non-destructive.

[c] The detail specification may additionally prescribe either or both endurance tests.

3.5 Quality conformance inspection

3.5.1 Formation of inspection lots

a) Groups A and B inspection

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

A manufacturer 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 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.

b) 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 high, medium and low voltage ratings. In order to cover the range of approvals in any period one case size shall be tested from each voltage group. In subsequent periods other case sizes and/or voltage ratings in production shall be tested with the aim of covering the whole range.

3.5.2 Test schedule

The schedule for the lot-by-lot and periodic tests for quality conformance inspection is given in Table 4 of the blank detail specification IEC 60384-17-1. .

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 Groups A and B inspection.

3.5.4 Assessment levels

The assessment level(s) given in the blank detail specification shall preferably be selected from the following Tables 5 and 6:

Table 5 – Lot-by-lot inspection

Inspection subgroup[b]	D[a]		E		F[a]		G[a]		EZ		
	IL	*AQL* %	*IL*	*AQL* %	*IL*	*AQL* %	*IL*	*AQL* %	*IL*	*n*	*c*
A0									100 %[c]		
A1			S-3	2,5						[d]	0
A2			S-3	1,0						[d]	0
B1			S-3	2,5						[d]	0

IL = inspection level;
AQL = acceptable quality level;
n = sample size;
c = permissible number of non-conforming items.

[a, b] See Table 6.

[c] 100 % testing shall be followed by re-inspection by sampling in order to monitor outgoing quality level by non-conforming items per million (10^{-6}). The sampling level shall be established by the manufacturer. For the calculation of 10^{-6} values any parametric failure shall be counted as non-conforming item. In case one or more non-conforming items occur in a sample, this lot shall be rejected.

[d] Number to be tested: Sample size as directly allotted to the code letter for *IL* in Table 2a of IEC 60410 .

Table 6 – Periodic inspection

Inspection subgroup[b]	D[a]			E			F[a]			G[a]			EZ		
	p	*n*	*c*	*p*	*n*	*c*	*p*	*n*	*c*	*p*	*n*	*c*	*p*	*n*	*c*
C1A				6	9	1							6	5	0
C1B				6	18	1							6	5	0
C1				6	27	2							6	10	0
C2				6	15	1							6	10	0
C3A				3	20	1							6	5	0
C3B				3	5	1							6	5	0
C3C				3	5	1							6	5	0
C4				3	9	1							6	10	0
C5				12	6	1							6	10	0

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

[a] The assessment levels D, F and G are under consideration.

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

4 Test and measurement procedures

4.1 Visual examination and check of dimensions

See 4.4 of IEC 60384-1.

4.2 Electrical tests

4.2.1 Voltage proof for a.c. capacitors

The detail specification shall state which voltage proof test, d.c. or a.c., is to be applied.

a) DC voltage proof test

– point 1a): 2,5 $U_{\mathrm{R}\sim}$

– point 1b) – 1c) – 1d) (insulated styles only): 1,4 $U_{\mathrm{R}\sim}$ + 2 000 V d.c.

NOTE If the capacitor has also a rated d.c. voltage, it must be tested with the d.c. voltage proof test of the d.c. specification (IEC 60384-16) but if the value mentioned here in item a) is higher, this value must be used.

b) AC voltage proof test (50 Hz or 60 Hz)

The r.m.s. value of the test voltage is:

– point 1a): 1,5 $U_{\mathrm{R}\sim}$ with $U_{\mathrm{R}\sim} \leq 250$ V
1,4 $U_{\mathrm{R}\sim}$ with $U_{\mathrm{R}\sim} > 250$ V

– point 1b) – 1c) – 1d) (insulated styles only): 1,4 $U_{\mathrm{R}\sim}$ + 2 000 V d.c.

NOTE 1 $U_{\mathrm{R}\sim}$ and other a.c. values are r.m.s. values.

NOTE 2 The test voltage must be applied during:
- One minute for qualification approval tests and periodic tests.
- A minimum of 1 s for lot-by-lot tests.

4.2.2 Capacitance

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

4.2.2.1 The capacitance shall be measured at, or corrected to, a frequency of 1 000 Hz. For rated capacitance values >10 µF, 50 Hz to 120 Hz may be used, but 1 kHz shall be the referee frequency.

The applied peak voltage at 1 000 Hz shall not exceed 3 % of the rated voltage, and the applied peak voltage at 50 Hz to 120 Hz shall not exceed 20 % of the rated voltage with a maximum of 100 V (70 V r.m.s.).

4.2.2.2 The capacitance shall be within the specified tolerance.

4.2.3 Tangent of loss angle (tan δ)

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

4.2.3.1 Measuring conditions for measurements at 1 000 Hz

Tan δ shall be measured as follows:

- frequency: 1 000 Hz;
- peak voltage: ≤3 % of the rated voltage;
- inaccuracy: $\leq 5 \times 10^{-4}$ (absolute value).

4.2.3.2 Requirement

Tan δ shall not exceed the values shown in the following table:

Table 7 – Tangent of loss angle

Measurement frequency	Rated capacitance	Tangent of loss angle	
		Performance Grade 1	Performance Grade 2
1 000 Hz	$C_R \leq 1$ µF	≤10 ×· 10^{-4}	≤20 × 10^{-4}
NOTE For C_R > 1µF, values of tan δ must be specified in the detail specification.			

4.2.3.3 Measuring conditions for measurements at 10 kHz

For capacitors with $C_R \leq 1$ µF, tan δ shall be measured as follows:

- frequency: 10 kHz;
- voltage: ≤1 V r.m.s.,
- inaccuracy: ≤5 × 10^{-4} (absolute value).

4.2.4 Insulation resistance

See IEC 60384-1, 4.5 with the following details:

4.2.4.1 Before measurement, the capacitor shall be fully discharged. The product of the resistance of the discharge circuit and the rated capacitance of the capacitor under test shall be ≥0,01 s or any other value prescribed in the detail specification.

4.2.4.2 The measuring voltage shall be in accordance with 4.5.2 of IEC 60384-1.

The voltage shall be applied immediately at the correct value through the internal resistance of the voltage source.

The product of the internal resistance and the rated capacitance of the capacitor shall be smaller than 1 s or any other value prescribed in the detail specification.

The insulation resistance shall meet the following requirements:

Table 8 – Insulation resistance requirements

Minimum RC product (R = insulation resistance between the terminations) (C = rated capacitance) s				Minimum insulation resistance between the terminations GΩ		Minimum insulation resistance between terminations and case GΩ
Measuring points in accordance with Table 3 of IEC 60384-1:						
1 a)				1 a)		1 b), 1 c)
Rated capacitance:						
>0,33 µF				≤0,33 µF		
Rated voltage:						
>100 V		≤100 V		All voltages		
Grade:						
1	2	1	2	1	2	
30 000	7 500	15 000	3 750	100	25	100

4.2.4.3 When the test is made at a temperature other than 20 °C, the result shall, when necessary, be corrected to 20 °C by multiplying the result of the measurement by the appropriate correction factor. In case of doubt, measurement at 20 °C is decisive. The following correction factors can be considered as an average for metallized polypropylene film capacitors:

Table 9 – Correction factors

Temperature °C	**Correction factor**
15	0,75
20	1
23	1,25
27	1,5
30	1,75
35	2

4.2.5 Inductance (if required)

See IEC 60384-1, 4.11 with the following details:

The maximum inductance value shall be stated in the detail specification.

An approximative value can be provided from measurement of resonance frequency and capacitance value measured in 4.2.2.

4.2.6 Characteristics depending on temperature (if required in the detail specification)

See IEC 60384-1, 4.24.1 with the following details:

The capacitance measurements shall be carried out at the temperatures given in items b), d) and f). The measurement of insulation resistance is also carried out at the temperature as given in item f).

Table 10 – Characteristics at lower category temperature

Test temperature as given in item b)	**Temperature characteristic of capacitance**
–10 °C and –25 °C	$0 \leq \frac{\Delta C}{C} \leq +2{,}25\ \%$
–40 °C	$0 \leq \frac{\Delta C}{C} \leq +3\ \%$
–55 °C	$0 \leq \frac{\Delta C}{C} \leq +3{,}75\ \%$

Table 11 – Characteristics at upper category temperature

Test temperature as given in item f)	**Temperature characteristic of capacitance**	**Insulation resistance (measuring point 1 a)**		**Insulation resistance (measuring point 1b), 1c) and 1d))**
		$C_{\mathrm{R}} > 0{,}33\ \mu\mathrm{F}$ $R_{\mathrm{i}} \times C_{\mathrm{R}}$ s	$C_{\mathrm{R}} > 0{,}33\ \mu\mathrm{F}$ R_{i} GΩ	GΩ
70 °C	$-2{,}5\ \% \leq \frac{\Delta C}{C} \leq 0$	1 500	5	5
85 °C	$-3{,}25\ \% \leq \frac{\Delta C}{C} \leq 0$	1 200	4	4
100 °C	$-4\ \% \leq \frac{\Delta C}{C} \leq 0$	750	2,5	2,5

4.3 Robustness of terminations

See IEC 60384-1, 4.13 with the following details:

4.3.1 Initial measurements

The capacitance shall be measured according to 4.2.2.

The tangent of loss angle shall be measured according to 4.2.3.1 or 4.2.3.3 as appropriate.

4.4 Resistance to soldering heat

See IEC 60384-1, 4.14 with the following details:

4.4.1 Conditions: No pre-drying

4.4.2 Final inspection, measurements and requirements

The capacitors shall be visually examined and measured and shall meet the requirements given in Table 4.

4.5 Solderability

See IEC 60384-1, 4.15 with the following details:

4.5.1 Test conditions: No ageing

The requirements for the globule test method shall be prescribed in the detail specification. When neither the solder bath nor the solder globule method is appropriate the soldering iron test shall be used with soldering iron Size A.

4.5.2 The performance requirements are given in Table 4.

4.6 Rapid change of temperature

See of IEC 60384-1, 4.16 with the following details:

4.6.1 Initial measurement

Initial measurements shall be made as prescribed by 4.3.1.

4.6.2 Number of cycles: 5

Duration of exposure at the temperature limits: 30 min, unless otherwise prescribed in the detail specification for larger capacitors. When prescribed in the detail specification, capacitors shall be measured after recovery; they shall meet the requirements of the detail specification.

4.7 Vibration

See IEC 60384-1, 4.17 with the following details:

4.7.1 The following degree of severity of test Fc applies:

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

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

4.7.2 Final inspection, measurements and requirements

See Table 4.

4.8 Bump

See IEC 60384-1, 4.18 with the following details:

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

4.8.1 Initial measurements

Not required.

4.8.2 The detail specification shall state which of the following severities applies:

Total number of bumps: 1 000 or 4 000

$$\left.\begin{array}{ll}\text{Acceleration:} & 400\ \text{m/s}^2 \\ \text{Pulse duration:} & 6\ \text{ms}\end{array}\right\}\ \text{or}\ \left\{\begin{array}{l}100\ \text{m/s}^2 \\ 16\ \text{ms}\end{array}\right.$$

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

4.8.3 Final inspection measurements and requirements

The capacitors shall be visually examined and measured and shall meet the requirements given in Table 4.

4.9 Shock

See IEC 60384-1, 4.19 with the following details:

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

4.9.1 Initial measurements

Not required.

4.9.2 The detail specification shall state which of the following preferred severities applies:

Pulse-shape: half-sine

Table 12 – Preferred severities

Peak acceleration m/s^2	Corresponding duration of the pulse ms
300	18
500	11
1000	6

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

4.9.3 Final inspection, measurements and requirements

The capacitors shall be visually examined and measured and shall meet the requirements given in Table 4.

4.10 Climatic sequence

See IEC 60384-1, 4.21 with the following details:

4.10.1 Initial measurements

Not required, see 4.4.2, 4.8.3 or 4.9.3 as applicable.

4.10.2 Dry heat

See IEC 60384-1, 4.21.2.

4.10.3 Damp heat, cyclic, Test Db, first cycle

See IEC 60384-1, 4.21.3.

4.10.4 Cold

See IEC 60384-1, 4.21.4.

4.10.5 Low air pressure

See IEC 60384-1, 4.21.5 with the following details:

4.10.5.1 The test, if required in the detail specification, shall be made at a temperature of 15 °C to 35 °C and a pressure of 8 kPa. The duration of the test shall be 1 h.

4.10.5.2 While still at the specified low pressure and during the last 5 min of the 1 h period, the rated voltage shall be applied.

The sample part of capacitors submitted to this test shall be subdivided into two or three parts as necessary and each part submitted to one of the tests laid down in Table 3 of IEC 60384-1. The test voltage shall be applied to terminations, case, etc., as given in 4.2.1.

4.10.5.3 Final inspection and requirements

The capacitors shall be visually examined and shall meet the requirements given in Table 4.

4.10.6 Damp heat, cyclic, Test Db, remaining cycles

See IEC 60384-1, 4.21.6 with the following details:

4.10.6.1 Within 15 min after removal from the damp heat test, the rated voltage shall be applied for 1 min at test point A using the test circuit conditions as given in 4.2.1.

4.10.6.2 Final inspection, measurements and requirements

After recovery, the capacitors shall be visually examined and measured and shall meet the requirements given in Table 4.

4.11 Damp heat, steady state

See IEC 60384-1, 4.22 with the following details:

4.11.1 Initial measurements

The capacitance shall be measured according to 4.2.2. The tangent of loss angle shall be measured according to 4.2.3.1.

4.11.2 Within 15 min after removal from the damp heat test, the voltage proof test according to 4.2.1 shall be carried out, but with the rated voltage applied.

4.11.3 Final inspection, measurements and requirements

After recovery, the capacitors shall be visually examined and measured and shall meet the requirements given in Table 4.

4.12 Endurance

See IEC 60384-1, 4.23 with the following details:

4.12.1 Endurance test at 50/60 Hz alternating voltage (if applicable)

4.12.1.1 Initial measurements

Initial measurements shall be made as prescribed by 4.3.1.

4.12.1.2 Conditions of test

In addition to 4.23 of IEC 60384-1 the following details apply, unless otherwise specified in the detail specification.

– Duration of test:	1 000 h ± 24 h
– Value of the applied voltage:	1,25 times the rated a.c. voltage (frequency: 50/60 Hz sinusoidal)
– Temperature of the chamber:	a.c. rated temperature
– Source impedance:	lower than 0,1 times the impedance of the group of capacitors under test

NOTE This test is not applicable for capacitors with rated a.c. voltages less than 200 V r.m.s.

4.12.1.3 Final examination, measurements and requirements

The capacitors shall be inspected and measured and shall meet the requirements given in Table 4.

4.12.2 Endurance test with sinusoidal current or voltage (if applicable)

NOTE Object of the test is to produce an average overheating of the capacitor by carrying out an endurance test with sinusoidal wave.

4.12.2.1 Initial measurements

Initial measurements shall be made as prescribed by 4.3.1.

4.12.2.2 Conditions of test

- Duration of test: 1 000 h ± 24 h
- r.m.s. current or voltage: 1,1 $^{+10}_{-0}$ % times the rated a.c. current or voltage (r.m.s.) with reference to the rated capacitance
- Frequency: to be given in the detail specification
- Test temperature: standard atmospheric conditions for testing

Reference document

See IEC 60384-1, 2.2.35 to 2.2.38 and 4.23.

NOTE 1 The r.m.s. value of the current must also be applicable to the lowest limit of the capacitance tolerance. The r.m.s. value of the voltage must also be applicable to the highest limit of the capacitance tolerance.

NOTE 2 If the capacitor is guaranteed in current, the test must be understood without any correction on the applied current. If the capacitor is guaranteed in voltage, the test mustl be understood without any correction on the applied voltage.

NOTE 3 For qualification approval, capacitors within 2 % from the lowest tolerance limit shall be selected for current testing. For qualification approval, capacitors within 2 % from the highest tolerance limit must be selected for voltage testing. No special selection shall be made for periodic tests.

4.12.2.3 Final inspection, measurements and requirements

The capacitors shall be inspected and measured and shall meet the requirements given in Table 4.

4.12.3 Pulse endurance test (if applicable)

NOTE The object of the test is to verify that the capacitor can withstand an endurance test of periodic pulses without significant temperature rise.

4.12.3.1 Initial measurements

Initial measurements shall be made according to 4.3.1.

4.12.3.2 Conditions of test

- Duration of test: 1 000 h ± 24 h
- Temperature: standard atmospheric conditions for testing
- Pulse repetition rate: according to the detail specification

  NOTE A frequency of 1 Hz may be used for $\frac{dU}{dt}$ ratings greater than 500 V/µs if 50/60 Hz gives a significant temperature rise (>10 °C).

- Applied peak voltage: equal to the rated peak voltage (to be given in the detail specification)
- Discharge time constant:
  - a) 1,5 times the rated value, when expressed by peak current per unit of capacitance (A/µF) or by the maximum $\frac{\mathrm{d}U}{\mathrm{d}t}$ (V/µs);
  - b) 0,67 times the rated value, when expressed by discharge time constant(s)

NOTE $\frac{I_\mathrm{p}}{C} = \frac{\mathrm{d}U}{\mathrm{d}t} = \frac{U}{R_\mathrm{d} \cdot C_\mathrm{R}}$ with $R_\mathrm{d} \cdot C_\mathrm{r}$ = discharge time constant.

- Charge time constant: 10 times the discharge time constant
- Duration of the charge period: >5 times the charge time constant
- Duration of the discharge period: >5 times the discharge time constant
- Maximum peak reverse voltage: 10 % of the applied peak voltage

4.12.3.3 Final examination, measurements and requirements

The capacitors shall be inspected and measured and shall meet the requirements given in Table 4.

4.13 Charge and discharge

NOTE The charge and discharge test is not applicable when the pulse endurance test is prescribed.

See 4.27 of IEC 60384-1, with the following details:

4.13.1 Initial measurements

Initial measurements shall be made as according to 4.3.1.

4.13.2 The capacitors shall be subjected to 10 000 cycles of charge and discharge at a rate of approximately one cycle per second. Each cycle shall consist of charging and discharging the capacitor. Each capacitor shall be individually charged with the rated voltage through a resistor with a value $\frac{220 \times 10^{-6}}{C_\mathrm{R}}$ Ω, where C_R is the rated capacitance in farads, or the value required to limit the charge current to 1 A (or to the higher current value given in the detail specification), whichever resistance value is the greater. Each capacitor shall be individually discharged through a resistor with a value of $\frac{10 \times 10^{-6}}{C_\mathrm{R}}$ Ω, with a minimum of 20 Ω, or a lower value, when prescribed in the detail specification, calculated as follows from the value of $\frac{\mathrm{d}U}{\mathrm{d}t}$ prescribed in the detail specification:

$$R = \frac{U}{C \cdot \frac{\mathrm{d}U}{\mathrm{d}t}}$$

4.13.3 Final measurements and requirements

After recovery, the capacitors shall be measured and shall meet the requirements given in Table 4.

4.14 Component solvent resistance

See 4.31 of IEC 60384-1.

4.15 Solvent resistance of the marking

See 4.32 of IEC 60384-1.

Bibliography

IEC 60065, *Audio, video and similar electronic apparatus – Safety requirements*

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

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Q1 Please report on **ONE STANDARD** and **ONE STANDARD ONLY**. Enter the exact number of the standard: *(e.g. 60601-1-1)*

....

Q2 Please tell us in what capacity(ies) you bought the standard *(tick all that apply).* I am the/a:

purchasing agent ☐
librarian ☐
researcher ☐
design engineer ☐
safety engineer ☐
testing engineer ☐
marketing specialist ☐
other...

Q3 I work for/in/as a: *(tick all that apply)*

manufacturing ☐
consultant ☐
government ☐
test/certification facility ☐
public utility ☐
education ☐
military ☐
other...

Q4 This standard will be used for: *(tick all that apply)*

general reference ☐
product research ☐
product design/development ☐
specifications ☐
tenders ☐
quality assessment ☐
certification ☐
technical documentation ☐
thesis ☐
manufacturing ☐
other...

Q5 This standard meets my needs: *(tick one)*

not at all ☐
nearly ☐
fairly well ☐
exactly ☐

Q6 If you ticked NOT AT ALL in Question 5 the reason is: *(tick all that apply)*

standard is out of date ☐
standard is incomplete ☐
standard is too academic ☐
standard is too superficial ☐
title is misleading ☐
I made the wrong choice ☐
other ....

Q7 Please assess the standard in the following categories, using the numbers:
(1) unacceptable,
(2) below average,
(3) average,
(4) above average,
(5) exceptional,
(6) not applicable

timeliness ....
quality of writing....................................
technical contents.................................
logic of arrangement of contents ....
tables, charts, graphs, figures...............
other ....

Q8 I read/use the: *(tick one)*

French text only ☐
English text only ☐
both English and French texts ☐

Q9 Please share any comment on any aspect of the IEC that you would like us to know:

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