INTERNATIONAL STANDARD

IEC 60384-4-1

QC 300301

Third edition
2007-03

Fixed capacitors for use in electronic equipment –

Part 4-1:
Blank detail specification –
Fixed aluminium electrolytic capacitors with non-solid electrolyte –
Assessment level EZ

Reference number
IEC 60384-4-1:2007(E)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 4-1: Blank detail specification – Fixed aluminium electrolytic capacitors with non-solid electrolyte – Assessment level EZ

FOREWORD

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International Standard IEC 60384-4-1 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This third edition cancels and replaces the second edition published in 2000 and constitutes a minor revision related to tables, figures and references.

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

CDV	Report on voting
40/1762/CDV	40/1820/RVC

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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

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

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- withdrawn,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 4-1: Blank detail specification – Fixed aluminium electrolytic capacitors with non-solid electrolyte – Assessment level EZ

Blank detail specification

A blank detail specification is a supplementary document to the sectional specification and contains requirements for style and layout and minimum content of detail specifications. Detail specifications not complying with these requirements may not be considered as being in accordance with IEC specifications nor shall they be so described.

In the preparation of detail specifications, the contents of 1.4 of the sectional specification shall be taken into account.

The numbers between brackets on the first page correspond to the following information which shall be inserted in the position indicated.

Identification of the detail specification

[1] The International Electrotechnical Commission or the National Standards Organization under whose authority the detail specification is drafted.

[2] The IEC or National Standards number of the detail specification, data of issue and any further information required by the national system.

[3] The number and issue number of the IEC or national generic specification.

[4] The IEC number of the blank detail specification.

Identification of the capacitor

[5] A short description of the type of capacitor.

[6] Information on typical construction (when applicable).

NOTE When the capacitor is not designed for use in printed board applications, this is clearly stated in the detail specification in this position.

[7] Outline drawing with main dimensions which are of importance for interchangeability and/or reference to the national or international documents for outlines. Alternatively, this drawing may be given in an annex to the detail specification.

[8] Application or group of applications covered and/or assessment level.

NOTE The assessment level(s) to be used in a detail specification are selected from 3.5.4 of the sectional specification. This implies that one blank detail specification may be used in combination with several assessment levels, provided the grouping of the tests does not change.

[9] Reference data on the most important properties, to allow comparison between the various capacitor types.

<table>
<tr><td>[1]</td><td>IEC 60384-4-1-XXX [2]
QC 300301-XXX</td></tr>
<tr><td rowspan="2">ELECTRONIC COMPONENTS OF ASSESSED QUALITY IN ACCORDANCE WITH:
IEC 60384-1
IEC 60384-4
[3]</td><td>IEC 60384-4-1 [4]
QC 300301</td></tr>
<tr><td rowspan="2">FIXED ALUMINIUM ELECTROLYTIC CAPACITORS WITH NON-SOLID ELECTROLYTE [5]</td></tr>
<tr><td>Outline drawing: (see Table 1)
(..... angle projection)
[7]</td></tr>
<tr><td rowspan="2">(Other shapes are permitted within the dimensions given.)</td><td>[6]</td></tr>
<tr><td>Assessment level(s): EZ [8]
Performance grade:</td></tr>
</table>

Information on the availability of components qualified to this detail specification is given in the IEC QC 001005.

[9]

1 General data

1.1 **Recommended method(s) of mounting** (to be inserted)

See 1.4.2 of IEC 60384-4.

1.2 Dimensions

Table 1 – Case size reference and dimensions

Case size reference	Dimensions mm						
	∅	*L*	*H*	*d*	.....		

NOTE 1 When there is no case size reference, Table 1 may be omitted and the dimensions given in Table 2, which then becomes Table 1.

NOTE 2 The dimensions are given as maximum dimensions or as nominal dimensions with a tolerance.

1.3 Ratings and characteristics

Capacitance range (see Table 2)

Tolerance on rated capacitance

Rated voltage (see Table 2)

Category voltage (if applicable) (see Table 2)

Climatic category

Rated temperature

Rated ripple current (see Table 3)

Tangent of loss angle (see Table 3)

NOTE Instead of the tangent of loss angle (tan δ), the equivalent series resistance ESR may be specified in accordance with 4.3.3.2d) of IEC 60384-4.

Leakage current

Impedance (if applicable) (see Table 3)

Reverse voltage (if required)

Insulation resistance (if applicable)

Table 2 – Values of capacitance and of voltage related to case sizes

Rated voltage				
Category voltage[a]				
	Case size	**Case size**	**Case size**	**Case size**
Rated capacitance µF				

[a] If different from the rated voltage.

Table 3 – Tangent of loss angle, impedance and rated ripple current

U_R V	C_R µF	Tangent of loss angle at..... °C,..... Hz	Impedance at..... °C, ... Hz (if applicable) Ω	Rated ripple current at..... °C,..... Hz A

1.4 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 60384-1, *Fixed capacitors for use in electronic equipment – Part 1: Generic specification*

IEC 60384-4, *Fixed capacitors for use in electronic equipment – Part 4: Sectional specification – Aluminium electrolytic capacitors with solid (MnO_2) and non-solid electrolyte*

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

1.5 Marking

The marking of the capacitor and the package shall be in accordance with the requirements of 1.6 of IEC 60384-4.

The details of the marking of the component and package are given in full in the detail specification.

1.6 Ordering information

Orders for capacitors covered by this specification shall contain, in clear or in coded form, the following minimum information.

a) Rated capacitance.

b) Tolerance on rated capacitance.

c) Rated d.c. voltage.

d) Number and issue reference of the detail specification and style reference.

1.7 Certified records of released lots

Required/not required.

1.8 **Additional information** (not for inspection purposes)

1.9 Additional or increased severities or requirements to those specified in the generic and/or sectional specification

NOTE Additions or increased requirements should be specified only when essential.

Table 4 – Other characteristics

This table is to be used for defining characteristics which are additional to, or more severe than, those given in the sectional specification.

2 Inspection requirements

2.1 Procedures

2.1.1 For qualification approval, the procedures shall be in accordance with 3.4 of the sectional specification, IEC 60384-4.

2.1.2 For quality conformance inspection, the test schedule (Table 5) includes sampling, periodicity, severities and requirements. The formation of inspection lots is covered by 3.5.1 of the sectional specification.

Table 5 – Test schedule for qualification conformance inspection

Subclause number and test[a]	D[b] or ND	Conditions of test [a]	*IL*[b]	*n*[b]	*c*[b]	Performance requirements[a]
Group A inspection (lot-by-lot)						
Subgroup A1	ND		S-3[c]	[c]	0	
4.2 Visual examination						As in 4.2
						Legible marking and as specified in 1.5 of this specification
4.2 Dimensions (gauging)						As specified in Table 1 of this specification
Subgroup A2	ND		S-3 [c]	[c]	0	
4.3.1 Leakage		Protective resistance:.... Ω				As in 4.3.1.2
4.3.2 Capacitance		Frequency:.... Hz				Within specified tolerance
4.3.3 Tangent of loss angle		Frequency:.... Hz				As in 4.3.3.2
4.3.4 Impedance (if applicable)		Frequency:.... Hz				Within limit specified in the detail specification

[a] Subclause number of tests and performance requirements refer to IEC 60384-4 and Clause 1 of this specification.

[b] In this table,
IL = inspection level (IEC 60410)
n = sample size
c = permissible number of non-conforming items
p = periodicity in months
D = destructive
ND = non-destructive

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

Table 5 *(continued)*

Subclause number and test[a]	D[b] or ND	Conditions of test[a]	*IL*[b]	*n*[b]	*c*[b]	Performance requirements[a e]
Group B inspection (lot-by-lot)						
Subgroup B1	ND		S-3[c]	[c]	0	
4.6 Solderability[d]		Method:.....				Good tinning as evidenced by free flowing of the solder with wetting of the terminations or meet the required parameter(s) in the detail specification as applicable
4.17.1 Initial measurement		Capacitance				
4.17 Storage at high temperature (if required)		Temperature: Upper category temperature				
		Duration: 96 h ± 4 h				
		Recovery: 16 h min.				
4.17.3 Final measurements		Visual examination				No visible damage and no leakage of electrolyte
		Leakage current				≤2 times the limits in 4.3.1
		Capacitance				$\Delta C/C$ ≤10 % of value measured in 4.17.1
		Tangent of loss angle				≤1,2 times the limit in 4.3.3
Subgroup B2	ND		S-3[c]	[c]	0	
4.19 Characteristics at high and low temperature		The capacitors shall be measured at each temperature step				
		Step 1: 20 °C				
		Impedance (at same frequency as Step 2)				
		Step 2: Lower category temperature				
		Impedance				Ratio with respect to value in Step 1

Rated voltage V	Ratio of impedance
U_R ≤ 6,3	≤ 10
6,3 < U_R ≤ 16	≤ 8
16 < U_R ≤ 160	≤ 6
160 < U_R	≤ 10

[a] Subclause number of tests and performance requirements refer to IEC 60384-4 and Clause 1 of this specification.

[b] In this table,

IL = inspection level (IEC 60410)
n = sample size
c = permissible number of non-conforming items
p = periodicity in months
D = destructive
ND = non- destructive

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

[d] Not applicable to capacitors with screw terminations or other terminations not designed to be soldered, as stated in the detail specifications.

[e] The tests in subgroup B1 are considered non-destructive provided that the (optional) high-temperature storage test is not applied. If the storage at high-temperature test is carried out, the capacitors are re-aged and submitted for inspection as part of a subsequent lot.

Table 5 *(continued)*

Subclause number and test[a]	D or ND	Conditions of test[a]	Sample size and criterion of acceptability[c]			Performance requirements[a]
			p	*n*	*c*	
Group C inspection (periodic)						
Subgroup C1A	D		6	9	0	
Part of sample of subgroup C1						
4.2 Dimensions (detail)						See detail specification
4.4.1 Initial measurement		Capacitance				
4.4 Robustness of terminations		Visual examination Method:..... Severity:.....				No visible damage
4.5 Resistance to soldering heat*		No pre-drying Method:.....				
4.5.2 Final measurements		Visual examination				No visible damage Legible marking
		Capacitance				$\Delta C/C$ ≤5 % of value measured in 4.4.1
Subgroup C1B	D		6	18	0	
Other part of sample of group C1						
4.7.1 Initial measurement		Capacitance				
4.7 Rapid change of temperature		T_A = lower category temperature T_B = upper category temperature Five cycles Duration t_1 = 30 min or 3 h Recovery: 16 h				
4.7.3 Final measurements		Visual examination				No visible damage and no leakage of electrolyte
4.8 Vibration		Method of mounting: see 1.1 of this specification Frequency range: ..... Hz to..... Hz Amplitude:..... mm or acceleration:..... m/s^2 (whichever is the less severe) Total duration:..... h				
4.8.2 Final measurements		Visual examination				No visible damage and no leakage of electrolyte. Legible marking
		Capacitance				$\Delta C/C$ ≤5 % of value measured in 4.7.1, unless otherwise specified in the detail specification

* Not applicable to capacitors with screw terminations or other terminations not designed to be soldered, as stated in the detail specification.

Table 5 *(continued)*

Subclause number and test[a]	D or ND	Conditions of test[a]	Sample size and criterion of acceptability[c]			Performance requirements[a]
			p	*n*	*c*	
Subgroup C1B (concluded)						
4.9 Bump (or shock, see 4.10)		Method of mounting: see 1.1 of this specification				
		Number of bumps:..... Acceleration: 400 m/s^2 Duration of pulse: 6 ms				
4.10 Shock (or bump, see 4.9)		Method of mounting: see 1.1 of this specification				
		Acceleration:..... m/s^2 Duration of pulse:..... ms				
4.9.2 or 4.10.2 Final measurements		Visual examination				No visible damage and no leakage of electrolyte
		Capacitance				$\Delta C/C$ ≤5 % of value measured in 4.7.1, unless otherwise specified in the detail specification
Subgroup C1	D		6	27	0	
Combined sample of specimens of subgroups C1A and C1B						
4.11 Climatic sequence						
4.11.1 Dry heat		Temperature: upper category temperature Duration: 16 h				
4.11.2 Damp heat, cyclic, test Db, first cycle						
4.11.3 Cold		Temperature: lower category temperature Duration: 2 h				
4.11.4 Low air pressure (if required by the detail specification)		Air pressure: 8 kPa				
4.11.4.3 Intermediate measurement		Visual examination				No breakdown, flashover or harmful deformation of the case
4.11.5 Damp heat, cyclic, Test Db, remaining cycles						
4.11.6 Sealing (if required by the detail specification)		Method:.....				
4.11.7 Final measurements		Visual examination				No visible damage and no leakage of electrolyte Legible marking
		Leakage current				As in 4.3.1
		Capacitance				$\Delta C/C$ ≤10 % of value measured in 4.5.2, 4.9.2 or 4.10.2 as applicable
		Tangent of loss angle				≤1,2 times limit in 4.3.3

Table 5 *(continued)*

Subclause number and test[a]	D or ND	Conditions of test[a]	Sample size and criterion of acceptability[c]			Performance requirements[a]	
			p	*n*	*c*		
Subgroup C2	D		6	9	0		
4.12 Damp heat, steady state							
4.12.1 Initial measurement		Capacitance					
4.12.2 Final measurements		Visual examination				No visible damage and no leakage of electrolyte Legible marking	
		Leakage current				As in 4.3.1	
		Capacitance				$\Delta C/C$ for ***Long-life grade:*** ≤10 % ***General-purpose grade:*** ≤20 % of value measured in 4.12.1	
		Tangent of loss angle				≤1,2 times limit in 4.3.3	
		Impedance				≤1,2 times limit in the detail specification	
		Insulation resistance of the external insulation (if applicable)				≥100 MΩ	
		Voltage proof of the external insulation (if applicable)				No breakdown or flashover	
Subgroup C3	D		3	21	0		
4.13 Endurance		Duration: ***Long-life grade:***: … h ***General-purpose grade:***: … h					
		Temperature: upper category temperature					
		Applied voltage:….. V					
		Recovery: 16 h min.					
4.13.1 Initial measurement		Capacitance					
4.13.3 Final measurements		Visual examination				No visible damage and no leakage of electrolyte[d]	
		Leakage current				As in 4.3.1	
		Capacitance				$\Delta C/C$ compared to values measured in 4.13.1	
						Long-life grade:	
						Rated voltage V	$\Delta C/C$ %
						U_R ≤6,3 6,3 < U_R ≤160 160 < U_R	+ 15 to – 30 ± 20 ± 15
						General-purpose grade:	
						Rated voltage V	$\Delta C/C$ %
						U_R ≤6,3 6,3 < U_R ≤160 160 < U_R	+ 25 to – 40 ± 30 ± 15

Table 5 *(continued)*

Subclause number and test[a]	D or ND	Conditions of test[a]	Sample size and criterion of acceptability[c]				Performance requirements[a]
			p	*n*	*c*		
Subgroup C3 (concluded)		Tangent of loss angle					***Long-life grade:*** ≤1,5 times the limit in 4.3.3 ***General-purpose grade:*** ≤2 times the limit in 4.3.3 or ≤0,4 whichever is the greater
		Impedance					***Long-life grade:*** ≤2 times limit in detail specification ***General purpose grade:*** ≤4 times the limit in detail specification
		Insulation resistance of the external insulation (if applicable)					≥100 MΩ
		Voltage proof of the external insulation (if applicable)					No breakdown or flashover
Subgroup C4A	D		12	6	0		
4.14 Surge		Number of cycles: 1 000 Temperature:..... °C Charge voltage: 1,15 U_R or 1,15 U_C for U_R ≤315 V or 1,10 U_R or 1,10 U_C for U_R > 315 V Duration of charge: 30 s Duration of non-load: 5 min 30 s					
4.14.1 Initial measurement		Capacitance					
4.14.3 Final measurements		Visual examination					No visible damage and no leakage of electrolyte[d]
		Leakage current					As in 4.3.1
		Capacitance					$\Delta C/C$ ≤15 % of value measured in 4.14.1
		Tangent of loss angle					As in 4.3.3
Subgroup C4B	D		12	6	0	0	
4.15 Reverse voltage (if required)		Duration: 125 h, at upper category temperature with a direct voltage of 1 V d.c. in reverse polarity direction, unless otherwise specified in the detail specification, followed by 125 h at upper category temperature with category voltage in forward polarity direction					
4.15.1 Initial measurement		Capacitance					
4.15.3 Final measurements		Leakage current					As in 4.3.1
		Capacitance					$\Delta C/C$ ≤..... % of value measured in 4.15.1
		Tangent of loss angle					As in 4.3.3
4.16 Pressure relief (if required)		Test method:.....					Device shall open without danger of explosion or fire

Table 5 *(continued)*

Subclause number and test[a]	D or ND	Conditions of test[a]	Sample size and criterion of acceptability[c]			Performance requirements[a]
			p	*n*	*c*	
Subgroup C5A	ND		6	12	0	
4.17 Storage at high temperature*		Temperature: upper category temperature Duration: 96 h ± 4 h Recovery: 16 h min.				
4.17.1 Initial measurement		Capacitance				
4.17.3 Final measurements		Visual examination				No visible damage and no leakage of electrolyte[d]
		Leakage current				≤2 times the limit in 4.3.1
		Capacitance				$\Delta C/C$ ≤10 % of value measured in 4.17.1
		Tangent of loss angle				≤1,2 times the limit in 4.3.3
4.22 Voltage transient overload (if required) ****						
4.22.1 Initial measurement		Capacitance				
4.22.2 Final measurements		Visual examination				See detail specification
		Capacitance				See detail specification
		Leakage current				See detail specification
		Tangent of loss angle				See detail specification
		Other parameters				See detail specification
Subgroup C5B**	ND		12	6	0	
4.18 Storage at low temperature		Duration: 16 h, or 4 h after thermal stability has been reached (whichever is the shorter) Temperature: –40 °C Recovery: 16 h min.				
4.18.1 Initial measurement		Capacitance				
4.18.2 Final measurements		Visual examination				No visible damage and no leakage of electrolyte Legible marking
		Leakage current				As in 4.3.1
		Capacitance				$\Delta C/C$ ≤10 % of value measured in 4.18.1
		Tangent of loss angle				As in 4.3.3
Subgroup C6	D		6	15	0	
4.19 Characteristics at high and low temperature		The capacitors shall be measured at each temperature step				
		Step 1: 20 °C Capacitance***				For use as reference value
		Tangent of loss angle***				For use as reference value
		Impedance (at same frequency as Step 2)				

* Not applicable if test is made in subgroup B1.

** This subgroup only applies to capacitors with a lower category temperature of –25 °C and –10 °C.

*** If applicable.

**** This test is applicable for only non-solid electrolyte capacitors and if required in the detail specification.

Table 5 *(continued)*

Subclause number and test[a]	D or ND	Conditions of test[a]	Sample size and criterion of acceptability[c]			Performance requirements[a]
			p	*n*	*c*	
Subgroup C6 (continued)		*Step 2:* Lower category temperature				
		Impedance				Ratio with respect to values in Step 1: Rated voltage V: Ratio of impedance $U_R \leq 6{,}3$: ≤ 10 $6{,}3 < U_R \leq 16$: ≤ 8 $16 < U_R \leq 160$: ≤ 6 $160 < U_R$: ≤ 10
		Step 3: Upper category temperature				
		Leakage current				At 125 °C: ≤0 times the limit of 4.3.1 At 105 °C: ≤8 times the limit of 4.3.1 At 100 °C: ≤8 times the limit of 4.3.1 At 85 °C: ≤5 times the limit of 4.3.1*
		Capacitance*				See detail specification
		Tangent of loss angle*				See detail specification
4.20 Charge and discharge (if required)		Temperature: 20 °C Number of cycles: $U_R \leq 160$ V: 10^6 $U_R > 160$ V: under consideration Duration of charge: 0,5 s Duration of discharge: 0,5 s				
4.20.1 Initial measurement		Capacitance				
4.20.3 Final measurements		Visual examination				No visible damage and no leakage of electrolyte
		Capacitance				$\Delta C/C$ ≤10 % of value measured in 4.20.1

* If applicable

[a] Subclause numbers of tests and performance requirements refer to IEC 60384-4 and Clause 1 of this specification.

[b] Inspection levels are selected from IEC 60410.

[c] In this table,

p is the periodicity (in months);

n is the sample size;

c is the acceptance criterion (permitted number of non conforming items);

D is destructive

ND is non-destructive;

IL is the inspection level (IEC 60410).

[d] When the detail specification indicates that a repetitive pressure-relief device is applied at the capacitor, the effects of the intended operation of the pressure-relief device (for example, slight colouring or discolouring, slight wetting, etc.) is not considered as leakage and/or visible damage. Seepage, however, is not permitted.

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