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IEC 62391-2

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2006-04

Fixed electric double-layer capacitors for use in electronic equipment –

Part 2: Sectional specification – Electric double-layer capacitors for power application

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International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIXED ELECTRIC DOUBLE-LAYER CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 2: Sectional specification – Electric double-layer capacitors for power application

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International Standard IEC 62391-2 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
40/1641/FDIS	40/1713/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 62391 consists of the following parts, under the general title *Fixed electric double-layer capacitors for use in electronic equipment:*

Part 1: Generic specification

Part 2: Sectional specification – Electric double-layer capacitors for power application

The sectional specification mentioned above does have a blank detail specification 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- withdrawn;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 standard may be issued at a later date.

FIXED ELECTRIC DOUBLE-LAYER CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 2: Sectional specification – Electric double-layer capacitors for power application

1 General

1.1 Scope

This part of IEC 62391 applies to electric double-layer capacitors for power application.

Electric double-layer capacitors for power are intended for applications that require discharge currents in the range from mA to A. The characteristics of the capacitors include such performance as relatively high capacitance and low internal resistance, which is applicable to Class 3 of the measurement classification specified in IEC 62391-1.

The definition of power density and its calculating procedure should be in accordance with Annex A.

1.2 Object

The object of this standard is to prescribe preferred ratings and characteristics and to select from IEC 62391-1 the appropriate quality assessment procedures, tests and measuring methods and to give general performance requirements for this type of capacitor. Test severities and requirements prescribed in detail specifications referring to this sectional specification shall be of equal or higher performance level; 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, *Preferred number series for resistors and capacitors*

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

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

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

IEC 62391-1, *Fixed electric double-layer capacitors for use in electronic equipment – Part 1: Generic specification* [1]

IEC 62391-2-1, *Fixed electric double-layer capacitors for use in electronic equipment – Part 2-1: Electric double-layer capacitors for power application – Assessment level EZ*

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 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, numerical values shall be given for the length of the body, the width and height of the body and wire spacing, or, for cylindrical types, the body diameter and length, and the length and diameter of the terminations. 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 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 test. The capacitors shall be mounted by their normal means. The design of the capacitor may be such that special mounting fixtures are required for 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 Rating and characteristics

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

1.4.3.1 Rated capacitance range

See 2.2.1.

NOTE When products approved to the detail specification have different ranges, the following statement should be added: “The range of capacitance values available in each voltage range is given in IEC QC 001005.”

1.4.3.2 Particular characteristics

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

1.4.3.3 Soldering

The detail specification shall prescribe the test methods, severities and requirements applicable to 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 Terminology

For the purposes of this document, the terms and definitions of IEC 62391-1, together with 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

1.5.2
electric double layer capacitors for power application
capacitors intended for the applications that require discharge currents in the range from mA to A

NOTE The characteristics of the capacitors include such performance as relatively high capacitance and low internal resistance, which is applicable to Class 3 of the measurement classification specified in IEC 62391-1.

1.6 Marking

IEC 62391-1, 2.4, applies 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 ⎓ or ——);

d) style (in accordance with 1.1);

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

f) manufacturer’s name or trade mark;

g) manufacturer’s type designation;

h) classification of processing lead terminals (if applicable).

1.6.2 Capacitors shall bear a), b) and c) in 1.6.1, and as many of the rest of the items as possible which should be as legible as possible. Indication of marked items on a capacitor shall not overlap.

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: −25 °C (−40 °C)

Upper category temperature: +60 °C and +70 °C

Duration of the damp-heat, steady-state test: 10 days

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

NOTE The damp-heat steady-state test conditions here should be at a temperature of 40 °C, and the relative humidity should be between 90 % and 95 %.

2.2 Preferred values of ratings

2.2.1 Rated capacitance (C_R)

The rated capacitance shall be expressed in farads (F) and as agreed between the sending and receiving parties. Preferred values of rated capacitance are the values from the E24 series of IEC 60063 and their decimal multiples.

2.2.2 Tolerance on rated capacitance

The preferred values of tolerance on rated capacitance are:

±20 % and −20 %/+80 %.

2.2.3 Rated voltage (U_R)

The rated voltage shall be as agreed between the sending and receiving parties. The preferred values of the rated direct voltages are taken from the R20 series of ISO 3 and their decimal multiples.

2.2.4 Rated temperature

The value of the rated temperature is 60 °C or 70 °C.

2.2.5 Internal resistance

The internal resistance shall be as agreed between the sending and receiving parties. The internal resistance shall be measured with the d.c. resistance method. However, if a coefficient can be obtained from both d.c. and a.c. resistance methods, the a.c. resistance method may be used for measurement.

3 Quality assessment procedures

3.1 Primary stage of manufacture

The primary stage of manufacture is the inspection process for activated carbon electrodes, provided that the activated carbon electrodes include the condition where the collector has been bonded in advance.

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.

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

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

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

3.4.2 Tests

The complete series of tests specified in Tables 1 and 2 is 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 specimens (Table 1) 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 nonconforming items does not exceed the specified number of permissible non-conforming items for each group or subgroup and the total number of permissible non-conforming items.

NOTE Tables 1 and 2 together form the fixed sample size test schedule. Table 1 includes the details for the sampling and permissible non-conforming items for the different tests or groups of tests. Table 2, 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 the detail specification.

The conditions of test and performance requirements for the fixed sample size test schedule should be identical to those prescribed in the detail specification for quality conformance inspection.

Table 1 – Fixed sample size test plan for qualification approval

Assessment level EZ

Group No.	Test	Subclause of this publication	Number of specimens n[a]	Permissible number of non-conforming items c
0[b]	Visual examination	4.3	56	0 [c)]
	Dimensions	4.3		
	Leakage current	4.4.1		
	Capacitance	4.4.2		
	Internal resistance	4.4.3		
	Spare specimens		2	
1A	Robustness of terminations	4.5	8	0
	Resistance to soldering heat	4.6		
1B	Solderability	4.7	8	0
	Rapid change of temperature	4.8		
	Vibration	4.9		
2	Endurance	4.10	16	0
3A	Self-discharge	4.11	8	0
	Storage at high temperature	4.12		
3B	Damp heat, steady state	4.14	8	0
4	Characteristics at high and low temperature	4.13	8	0
4A	Passive flammability (if applicable)	4.15	4	0
4B	Pressure relief (if applicable)	4.16	4	0

[a] For case size/voltage combinations, see 3.4.1.

[b] The values of these measurements serve as initial measurements for the tests of Subgroup 0.

[c] Specimens found to be nonconforming shall not be taken into account when calculating the permissible non-conforming items for the following tests. They shall be replaced by spare parts.

Table 2 – Tests schedule for qualification approval

Subclause number and test[a]	D or ND[b]	Conditions of test[a]	n and c[b]	Performance requirements[a]
Group 0	ND		See Table 1	
4.3 Visual examination				As in 4.3.2
				Legible marking and as specified in the detail specification
4.4 Dimension (detail)				See the detail specification
4.4.1 Leakage current		Protective resistor: .... Ω		As in 4.4.1.2
4.4.2 Capacitance		Per Class 3		As in 4.4.2.2
4.4.3 Internal resistance		D.C. resistance [d)]: per Class 3		As in 4.4.3.2
Group 1A	D		See Table 1	
4.5 Robustness of terminations		Test method:		
		Test U_{a1} (Tensile strength)		
		Test U_b (Bending strength)		
4.5.1 Initial measurement		Capacitance		
4.5.2 Final measurement		Visual examination		No visible damage Legible marking
		Capacitance		$\Delta C/C \leq 10$ % of value measured in 4.5.1
4.6 Resistance to soldering heat[c]		Method 1a of Test Tb		
		Recovery: ...		
4.6.1 Initial measurement		Capacitance		
4.6.3 Final measurement		Visual examination		No visible damage Legible marking and no leakage of electrolyte
		Capacitance		$\Delta C/C \leq 10$ % of value measured in 4.6.1
Group 1B	D		See Table 1	
4.7 Solderability[c]		Test method: Solder bath method (Method 1)		
4.7.1 Final measurement		Visual examination		75 % or more of terminals shall be covered with new solder
4.8 Rapid change of temperature		T_A: Lower category temperature T_B: Upper category temperature 5 cycles		
		Test time t_1:		
4.8.1 Initial measurement		Visual examination capacitance		
4.8.3 Final inspection		Visual examination capacitance		No visible damage and no leakage of electrolyte
				$\Delta C/C \leq 10$ % of value measured in 4.8.1 for capacitance
4.9 Vibration		Mounting method: see 1.4.2		
4.9.1 Initial measurement		Capacitance (the value obtained in 4.8.3 may be used)		
4.9.3 Final inspection		Visual examination		No visible damage Legible marking and no leakage of electrolyte
		Capacitance		$\Delta C/C \leq 10$ % of value measured in 4.9.1

Subclause number and test[a]	D or ND[b]	Conditions of test[a]	n and c[b]	Performance requirements[a]
Group 2	D		See Table 1	
4.10 Endurance		Duration: 1 000 h for upper category temperature 70 °C grade capacitors 2 000 h for upper category temperature 60 °C grade capacitors Voltage: … V Recovery: 16 h min		
4.10.1 Initial measurement		Capacitance		
4.10.3 Final measurements		Visual examination		No visible damage and no leakage of electrolyte
		Capacitance		$\Delta C/C \leq 30$ % of value measured in 4.10.1
		Internal resistance		≤ 4 times the limit specified in 4.4.3
Group 3A	D		See Table 1	
4.11 Self-discharge		Discharge time: ..... Charge voltage: ..... Charge time: 8 h Measurement time:		
4.11.2 Final measurements		Retention voltage		Retention voltage after a 24 h exposure at room temperature after charge shall be 80 % or more of the charge voltage
4.12 Storage at high temperature		Test temperature: upper category temperature Duration: 96 h ± 4 h Recovery: 16 h min.		
4.12.1 Initial measurement		Capacitance		
4.12.3 Final measurements		Visual examination		No visible damage and no leakage of electrolyte
		Capacitance		$\Delta C/C \leq 10$ % of value measured in 4.12.1
		Internal resistance		≤ 2 times the limit specified in 4.4.3
Group 3B	D		See Table 1	
4.14 Damp heat, steady state		Temperature, humidity: 40 °C, 90 % to 95 % Time: 10 days		
4.14.1 Initial measurement		Capacitance		
4.14.3 Final measurements		Visual examination		No visible damage and no leakage of electrolyte
		Capacitance		$\Delta C/C \leq 30$ % of value measured in 4.14.1
		Internal resistance		≤ 4 times the limit specified in 4.4.3

Subclause number and test[a]	D or ND[b]	Conditions of test[a]	n and c[b]	Performance requirements[a]
Group 4	D		See Table 1	
4.13 Characteristics at high and low temperature		The capacitors shall be measured at each temperature step		
		Step 1: 20 °C		For use as reference value
		Capacitance		
		Step 2: lower category temperature		
		Capacitance		$\Delta C/C \leq 30$ % of value measured in Step 1
		Internal resistance		≤ 4 times the limit specified in 4.4.3.2
		Step 3: upper category temperature		
		Capacitance		$\Delta C/C \leq 30$ % of value measured in Step 1
		Internal resistance		≤ the limit specified in 4.4.3.2
Group 4A	D		See Table 1	
4.15 Passive flammability (if applicable)		Category of flammability:		As in 4.15.1
Group 4B	D		See Table 1	
4.16 Pressure relief (if applicable)		Applied voltage:		As in 4.16.1

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

[b] In this table: D = destructive;
ND = non-destructive;
n = sample size;
c = acceptance criterion (permitted number of nonconforming items).

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

[d] The a.c. resistance method shall be used when a correlation is found with the results of the d.c. measuring method. The measuring method shall be in accordance with 4.6.1 (a.c. resistance method) of IEC 62391-1.

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 manufacturer may aggregate the current production into inspection lots subject to the following safeguards.

a) The inspection lot shall consist of structurally similar capacitors (see 3.2).

b) 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.

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 Table 4 of the blank detail specification, IEC 62391-2-1.

3.5.3 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 [d]					EZ						
					IL[a]	n[a]	c[a]				
A0					100 % [b]						
A1					S-3	[c]	0				
A2					S-3	[c]	0				
B1, B2					S-3	[c]	0				

[a] IL is the inspection level;
n is the sample size;
c is the permissible number of nonconforming items.

[b] 100 % testing shall be followed by re-inspection by sampling in order to monitor the 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 IIA of IEC 60410 (single sampling plan for normal inspection).

[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								
							p[a]	n[a]	c[a]						
C1A							12	8	0						
C1B							12	8	0						
C2							6	16	0						
C3A							6	8	0						
C3B							6	8	0						
C4							12	8	0						

[a] p is the periodicity in months;
n is the sample size;
c is the 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 section supplements the information given in IEC 62391-1, Clause 4.

4.1 Preliminary drying

If prescribed in the detail specification, the conditions as given in IEC 62391-1, 4.3.

4.2 Measuring conditions

See IEC 62391-1, 4.2.1.

4.3 Visual examination and check of dimensions

See IEC 62391-1, 4.4, with the following details.

4.3.1 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 facilities available for incident or transmitted illumination as well as an appropriate measuring facility.

4.3.2 Requirements

The 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.

4.4 Electrical tests

4.4.1 Leakage current

See IEC 62391-1, 4.7 with the following details:

4.4.1.1 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 or less.

Unless otherwise agreed upon between the trading partners, the discharge time before test shall be 12 h or longer.

Unless otherwise agreed upon between the trading partners, the electrification time shall be 24 h.

4.4.1.2 Requirements

The leakage current (at 20 °C) shall meet the requirements of the detail specification.

4.4.2 Capacitance

See IEC 62391-1, 4.5.1, with the following details:

4.4.2.1 Measuring conditions

The ambient temperature shall be 20 °C ± 2 °C.

The measurement shall be made under the conditions of IEC 62391-1, 4.5.1.2, Class 3.

4.4.2.2 Requirements

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

4.4.3 Internal resistance

See IEC 62391-1, 4.6.2, with the following details.

NOTE The a.c. resistance method should be used when a correlation is found with the results of the d.c. measuring method. The measuring method should be in accordance with IEC 62391-1, 4.6.1.

4.4.3.1 Measuring conditions

The ambient temperature shall be 20 °C ± 2 °C.

The measurement shall be made under the conditions of IEC 62391-1, 4.6.2.1, Class 3.

4.4.3.2 Requirements

The internal resistance shall meet the requirements of the detail specification.

4.5 Robustness of terminations

See IEC 62391-1, 4.9, with the following details.

The detail specification shall specify the test method and degree of severity to be used.

4.5.1 Initial measurement

The capacitance shall be measured according to 4.4.2.

4.5.2 Final inspection, measurements and requirements

The capacitors shall be visually examined and shall meet the requirements shown in Table 2.

4.6 Resistance to soldering heat

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

See IEC 62391-1, 4.10, with the following details.

4.6.1 Initial measurement

The capacitance shall be measured according to 4.4.2.

4.6.2 Conditions

No pre-drying.

The capacitors shall be subjected to method 1A of Test Tb.

Immersion time shall be 5 s ± 0,5 s.

4.6.3 Final inspection, measurements and requirements

The capacitors shall be visually examined and measured electrically and shall meet the requirements shown in Table 2.

4.7 Solderability

See IEC 62391-1, 4.11, with the following details.

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

4.7.1 Final inspection, measurements and requirements

The capacitors shall be visually examined and shall meet the requirements shown in Table 2.

4.8 Rapid change of temperature

See IEC 62391-1, 4.12, with the following details.

4.8.1 Initial measurement

The capacitance shall be measured according to 4.4.2.

4.8.2 Conditioning

The capacitance shall be subjected to test Na for 5 cycles.

The duration of the exposure at each temperature limit shall be 30 min or 3 h as specified in the detail specification.

The recovery period shall be 16 h.

4.8.3 Final inspection, measurements and requirements

After recovery, the capacitors shall be visually examined and measured electrically and shall meet the requirements shown in Table 2.

4.9 Vibration

See IEC 62391-1, 4.13 with the following details.

4.9.1 Initial measurement

Capacitance shall be measured according to 4.4.2.

4.9.2 Test condition

Test Fc, Procedure B4, shall be applied with following severities.

Frequency range: 10-55 Hz

Amplitude: 0,75 mm or acceleration: 100 m/s^2 (whichever is less stringent)

Total test time: 6 h

4.9.3 Final inspection, measurements and requirements

The capacitors shall be visually examined and measured and shall meet the requirements shown in Table 2.

4.10 Endurance

See IEC 62391-1, 4.15, with the following details.

4.10.1 Initial measurement

The capacitance shall be measured according to 4.4.2.

4.10.2 Test conditions

Duration: 1 000 h for upper category temperature 70 °C grade capacitors;
2 000 h for upper category temperature 60 °C grade capacitors.

Applied voltage: category voltage, unless otherwise specified in the detail specification.

NOTE When the category voltage is different from the rated voltage, the sample tested is divided into two parts and submitted to the rated temperature at the category voltage respectively.

4.10.3 Final inspection, measurements and requirements

After recovery for minimum of 16 h, the capacitors shall be visually examined and measured and shall meet the requirements shown in Table 2.

4.11 Self-discharge

See IEC 62391-1, 4.8, with the following details.

4.11.1 Test conditions

Unless otherwise agreed upon between the trading partners, the discharge time before test shall be 12 h or longer.

The charge voltage shall be the rated voltage. The requirement for another charge voltage shall be prescribed in the detail specification.

Charge time: 8 h.

4.11.2 Final inspection, measurements and requirements

Unless otherwise agreed upon between the trading partners, the measurement time shall be 24 h.

The capacitors shall be measured retention voltage and shall meet the requirements shown in Table 2.

4.12 Storage at high temperature

See IEC 62391-1, 4.16, with the following details.

4.12.1 Initial measurement

The capacitance shall be measured according to 4.4.2.

4.12.2 Test condition

Temperature: upper category temperature;

Duration: 96 h ± 4 h.

4.12.3 Final inspection, measurements and requirements

After recovery for minimum 16 h, the capacitors shall be visually examined and measured and shall meet the requirements given in Table 2.

4.13 Characteristics at high and low temperature

See IEC 62391-1, 4.17, with the following details.

4.13.1 Measurements and requirements

The capacitor shall be measured and shall meet the requirements shown in Table 2.

4.14 Damp heat, steady state

See IEC 62391-1, 4.14 with the following details.

4.14.1 Initial measurement

The capacitance shall be measured according to 4.4.2.

4.14.2 Conditions of test

No voltage shall be applied.

4.14.3 Final inspection, measurements and requirements

After recovery for 1 h to 2 h, the capacitors shall be visually examined and measured electrically and shall meet the requirements shown in Table 2.

4.15 Passive flammability (if applicable)

See IEC 62391-1, 4.20, with the following details.

No preconditioning is required.

The flame shall be applied for the period of the time specified in IEC 62391-1 corresponding to the volume of the specimen and the category of flammability specified in the detail specification.

Unless otherwise specified in the detail specification, the flammability category shall be C.

4.15.1 Requirement

The burning time specified in IEC 62391-1 shall not be exceeded.

4.16 Pressure relief (if applicable)

See IEC 62391-1, 4.21.

4.16.1 Requirement

The pressure relief device shall open in such a way as to avoid any danger of explosion or fire.

Annex A
(informative)

Calculation procedure for power density

A.1 Scope

Annex A specifies definition and calculation procedure of the power density.

A.2 Definition of power density

Power indicates the electric power that can be taken from a capacitor, expressed in watts (W). Power density indicates the electric power that can be taken out per mass (or volume) of a capacitor. The higher the power density is, the higher current can be taken efficiently.

A.3 Calculation procedure for power density

A.3.1 Calculation method of power density per mass

a) Measure the internal resistance specified in section 4.6.2 of IEC 62391-1.

b) Calculate the discharge current value I where U_6 is 20 % (0,2 $\times$ U) of the charge voltage by the following formula (see Figure A.1).

$I = U_6/R_d$

where R_d is the internal resistance obtained by d.c. resistance method.

c) The power density per mass P_d is calculated by the following formula.

$P_d = 1/2\times(U - U_6 + U_e) \times I/m$

$= (0{,}12 \times U^2/R_d)\ /m$

where

P_d is power density per mass (W/kg);

U is charge voltage (V);

U_6 is drop voltage (V), which is 20 % (0,2 U) of the charge voltage;

U_e is 40 % (0,4 U) of the charge voltage (V);

I is the discharge current calculated in A.3.1 b) (A);

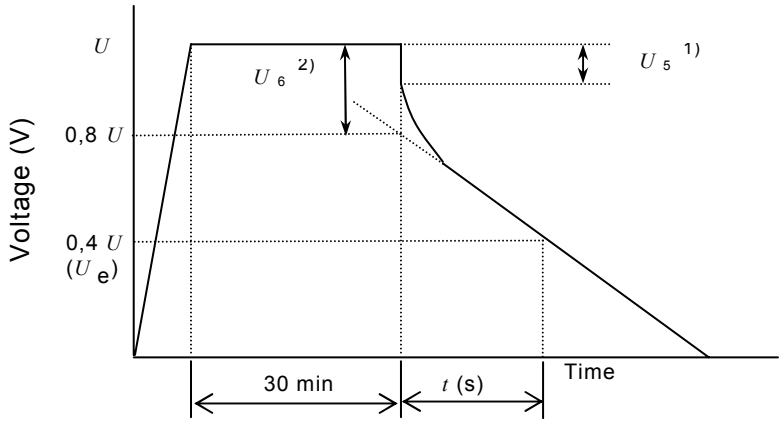
R_d is the internal resistance(Ω) obtained by d.c. resistance method;

m is the weight of a capacitor (kg).

A.3.2 Calculation method of power density per volume

Indication of the power density per volume of a capacitor is calculated by replacing the mass of the capacitor in A.3.1 c) with the capacitor volume.

NOTE The capacitor volume here is calculated from the nominal dimensions of the capacitor, expressed in litres (L).



1) The drop voltage does not indicate the voltage U_5 that drops instantaneously at the time of discharge start, but the dropped voltage U_6 obtained from the intersection of the auxiliary line extended from the straight part and the time base at the time of discharge start.

2) Where discharge current I is specified in detail specification, U_6 is not necessarily $0{,}2 \times U$.

Figure A.1 – Voltage characteristics between capacitor terminals

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tenders ❑
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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 ❑
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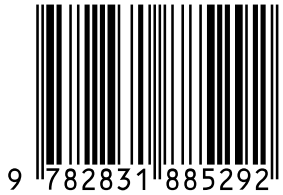

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