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Lithium-ion capacitors for use in electric and electronic equipment – Test methods for electrical characteristics

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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LITHIUM-ION CAPACITORS FOR USE IN ELECTRIC AND ELECTRONIC EQUIPMENT – TEST METHODS FOR ELECTRICAL CHARACTERISTICS

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IEC 62813 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment. It is an International Standard.

This second edition cancels and replaces the first edition published in 2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) The document has been restructured to comply with the ISO/IEC Directives, Part 2.

The text of this International Standard is based on the following documents:

Draft	Report on voting
40/3178/FDIS	40/3195/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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- withdrawn, or
- revised.

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LITHIUM-ION CAPACITORS FOR USE IN ELECTRIC AND ELECTRONIC EQUIPMENT – TEST METHODS FOR ELECTRICAL CHARACTERISTICS

1 Scope

This International Standard specifies the electrical characteristics (capacitance, internal resistance, discharge accumulated electric energy, and voltage maintenance rate) test methods of lithium-ion capacitors (LIC) for use in electric and electronic equipment.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60068-1:2013, *Environmental testing – Part 1: General and guidance*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

~~NOTE The terms printed in italics are those which are defined in this Clause 3.~~

3.1
upper category temperature
highest ambient temperature including internal heating in which a LIC is designed to operate continuously

[SOURCE: ~~IEC 62576:2009, 3.3, modified~~ IEC 61881-3:2012, 3.17, modified – The note to entry has been deleted.]

3.2
rated voltage
U_R
maximum direct current (DC) voltage that may be applied continuously for a certain time under the *upper category temperature* (3.1) to a LIC so that it can exhibit specified demand characteristics

Note 1 to entry: This voltage is the setting voltage in LIC design.

Note 2 to entry: The endurance test using the rated voltage is described in Annex A.

[SOURCE: ~~IEC 62576:2009, 3.6, modified~~ IEC 62576:2018, 3.20, modified – The word "capacitor" has been replaced by "LIC".]

3.3
rated lower limit voltage
U_L
minimum DC voltage such that a LIC can exhibit specified demand characteristics

Note 1 to entry: The rated lower limit voltage is designated by manufacturer.

3.4
charging current
current required to charge a LIC

3.5
discharging current
current required to discharge a LIC

3.6
discharge accumulated electric energy
amount of discharged energy of a LIC accumulated from the *discharge start time* (3.7) to the *time to reach rated lower limit voltage* (3.10)

3.7
discharge start time
T_0
time when discharge of a LIC starts

Note 1 to entry: It is the basis time for the *calculation start time* (3.8) and the *time to reach rated lower limit voltage* (3.10).

3.8
calculation start time
T_1
time at a selected start point used to calculate the *capacitance* (3.12) and the *internal resistance* (3.14) during discharge of a LIC

Note 1 to entry: The calculation start time is expressed as elapsed time since the *discharge start time* (3.7).

3.9
calculation end time
T_2
time at a selected end point used to calculate the *capacitance* (3.12) and the *internal resistance* (3.14) during discharge of a LIC

Note 1 to entry: The calculation end time is expressed as elapsed time since the *discharge start time* (3.7).

3.10
time to reach rated lower limit voltage
T_L
time when the voltage reaches the *rated lower limit voltage* (3.3) during discharge of a LIC

Note 1 to entry: The time to reach rated lower limit voltage is expressed as elapsed time since the *discharge start time* (3.7).

3.11
instant drop voltage at discharge
U_0
voltage at the *discharge start time* (3.7) of a least-squares regression line over the time period from the *calculation start time* (3.8) to the *calculation end time* (3.9) for the voltage drop characteristic of a LIC during discharge

3.12
capacitance
ability of a LIC to store electrical charge (F)

[SOURCE: IEC 62576:~~2009~~2018, 3.5, modified – The word “capacitor” has been replaced by “LIC”.]

3.13
nominal capacitance
C_N
designated capacitance value ~~designated by manufacturer,~~ usually indicated on a LIC

[SOURCE: ~~IEC 62576:2009, 3.15, modified~~ IEC 62391-1:2022, 3.21, modified – The words "on the capacitor" have been replaced by "on a LIC".]

3.14
internal resistance
resistance component in an equivalent series circuit of capacitance and resistance of a LIC

[SOURCE: ~~IEC 62391-1:2006, 2.2.20, modified~~ IEC 62391-1:2022, 3.10, modified – The words "resistance of a capacitor" have been replaced by "resistance of a LIC".]

3.15
nominal internal resistance
R_N
~~internal resistance value designated by manufacturer, usually indicated on a LIC~~

~~[SOURCE: IEC 62576:2009, 3.17, modified]~~
nominal value of the internal resistance to be used in design and measurement condition setting, generally at the ambient temperature

[SOURCE: IEC 62576:2018, 3.17, modified – The information given between parentheses "(R_N)" and "(Ω)" have been removed from the descriptive statement.]

3.16
constant voltage charging
~~method of charging a LIC at specified constant voltage~~

charging during which the voltage is maintained at a constant value regardless of charge current or temperature

[SOURCE: IEC 62576:~~2009~~2018, ~~3.18, modified~~ 3.9]

3.17
constant current charging
method of charging a LIC with specified constant current

3.18
constant current discharging
method of discharging a LIC with specified constant current

3.19
pre-conditioning
charging and discharging and storage of a LIC under specified ~~atmospheric~~ ambient conditions (temperature, humidity, and ~~air~~ pressure) before testing

Note 1 to entry: Generally, pre-conditioning implies that the LIC is stored until its inner temperature attains thermal equilibrium with the surrounding temperature, before its electrical characteristics are measured.

[SOURCE: IEC 62576:~~2009~~2018, 3.19, modified – The word "capacitor" has been replaced by "LIC" in the definition and in the note.]]

3.20
voltage maintenance rate
A
ratio of the voltage at the open-ended terminals to the charge voltage after a specified time period subsequent to the charging of a LIC

[SOURCE: IEC 62576:~~2009~~2018, 3.25, modified – The word "capacitor" has been replaced by "LIC".]

4 Test methods

4.1 Test requirements

4.1.1 Standard atmospheric conditions for tests

Unless otherwise specified in the detail specification, all tests shall be made under standard atmospheric conditions for tests as given in IEC 60068-1:2013, 4.3:

– temperature: 15 °C to 35 °C;
– relative humidity: 25 % to 75 %;
– air pressure: 86 kPa to 106 kPa.

If any question about determining measurement value arises under the atmospheric conditions or if it is requested, 4.1.2 is applied.

If it is difficult to perform measurements under the standard atmospheric conditions and if no question about determining measurement value arises, tests and measurements may be performed under other conditions than the standard atmospheric conditions.

4.1.2 Standard atmospheric conditions for measurements

Unless otherwise specified in the detail specification, all measurements shall be made under standard atmospheric conditions for ~~measurements~~ testing as given in IEC 60068-1:2013, 4.3, with the following details:

– temperature: 25 °C ± 2 °C;
– relative humidity: 45 % to 55 %;
– air pressure: 86 kPa to 106 kPa.

4.1.3 Pre-conditioning

Unless otherwise specified in the detail specification, the LIC shall be charged with a constant current and constant voltage power supply, the voltage of which is set to the rated voltage, for 30 min then discharged to the lower limit voltage with a proper discharging device.

4.2 Measurement

4.2.1 Capacitance, discharge accumulated electric energy, and internal resistance

4.2.1.1 Test equipment

The test equipment shall be capable of constant current charging, constant voltage charging, and constant current discharging with current specified in 4.2.1.2, and continuous measurement

of current and voltage at ~~specified~~ sampling interval specified in 4.2.1.2 f) 1). The basic circuit is shown in Figure 1.

a) DC power supply

The DC power supply shall be capable of charging the LIC at ~~specified~~ constant current specified in 4.2.1.2 c) and ~~specified~~ constant voltage specified in 4.2.1.2 d) for duration specified in 4.2.1.2 d).

b) Constant current load

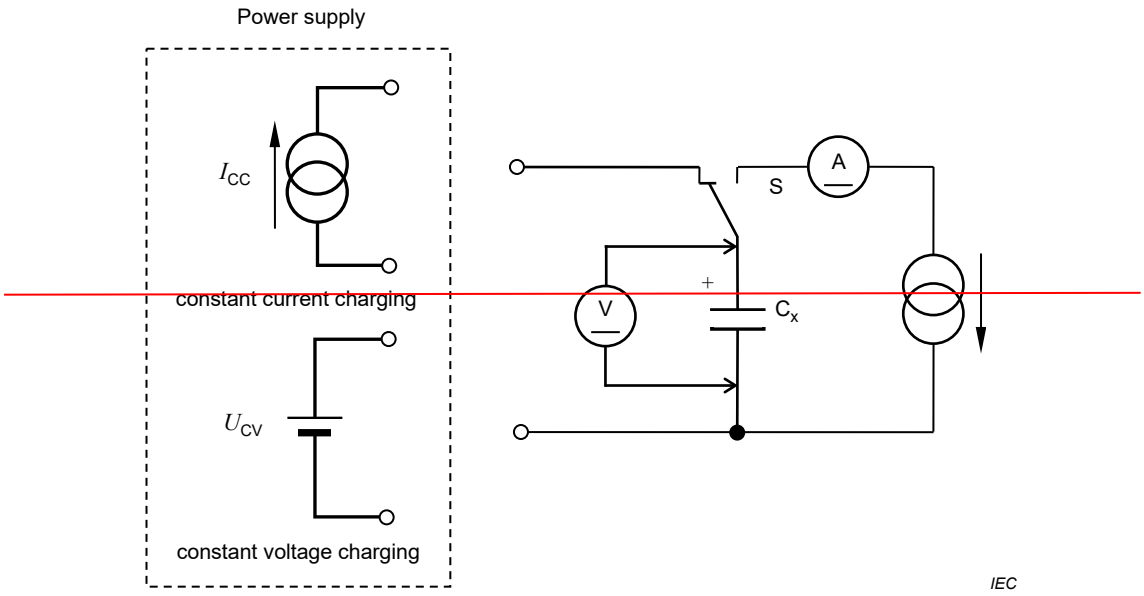
The constant current load shall be capable of discharging the LIC at ~~specified~~ constant current specified in 4.2.1.2 e) and its current rise time at discharge start shall be 50 ms or less.

c) DC voltage recorder

The DC voltage recorder shall be capable of conducting measurements and recording with 1 mV resolution and sampling interval of 100 ms.

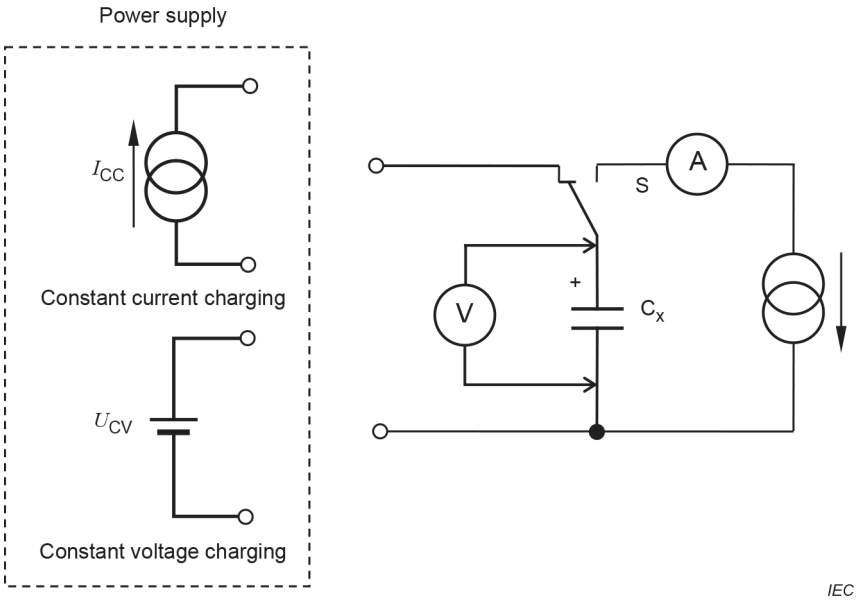
d) Changeover switch

The changeover switch shall not cause chattering which may affect the result of voltage-time recording.



Key

I_{CC}	constant-current
U_{CV}	constant-voltage
A	D.C. ammeter
V	D.C. voltage recorder
S	changeover switch
C_x	LIC under test
	constant current power supply
	constant voltage power supply
	constant current load



Key

I_{CC}	constant-current
U_{CV}	constant-voltage
(A)	DC ammeter
(V)	DC voltage recorder
S	changeover switch
C_x	LIC under test
	constant current power supply
	constant voltage power supply
	constant current load

Figure 1 – Basic circuit for measuring capacitance, discharge accumulated electric energy, and internal resistance

4.2.1.2 Measurement procedure and conditions

The measurement procedure and conditions shall be as follows. The voltage profile between the LIC terminals in the measurement shall be as shown in Figure 2.

a) Before setting sample

The LIC shall be left in the standard atmospheric condition as defined in 4.1.1 for 2 h to 6 h.

b) Sample setting

Connect the LIC terminals to the circuit.

c) Constant current charging

Charge the LIC to the rated voltage U_R with DC power supply specified in 4.2.1.1 and with specified current I calculated by Formula (1).

$$I = \frac{1}{30R_N}\sqrt{1+\frac{27}{5C_NR_N+1}-\frac{26}{10C_NR_N+1}} \quad (1)$$

where

I is the charging current (A). It is also used to specify the discharging current;

R_N is the nominal internal resistance of the LIC under test (Ω);

C_N is the nominal capacitance of the LIC under test (F).

NOTE The current calculated by Formula (1) is assumed as the current by which the resultant measurement error of the internal resistance is limited within ± 3 % (see Annex B). When the nominal value of internal resistance is uncertain, the current for the measurement can be set according to the advisable procedures described in Annex C.

d) Constant voltage charging

When voltage between the LIC terminals is reached to the rated voltage U_R, switch to constant voltage charging then apply the rated voltage U_R for 30 min.

e) Constant current discharging

Turn changeover switch from the power supply to the constant current load and discharge with the specified constant current as follows:

1) For internal resistance measurement, set the discharge current: I calculated by Formula (1).

2) For discharge accumulated electric energy and capacitance measurement, set the discharge current: I_{cap}, tenth of I calculated by Formula (1).

f) Test, measurement and recording

Measure and record the voltage-time characteristics between the LIC terminals:

1) Sampling and recording interval ΔT_s shall be set to ~~100 ms~~ 0,1 s.

2) Sampling and recording shall be conducted continuously from charge start time to the time to reach rated lower limit voltage U_L.