

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for portable applications – Part 3: Prismatic and cylindrical lithium secondary cells, and batteries made from them

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Accumulateurs alcalins et autres accumulateurs à électrolyte non acide – Accumulateurs au lithium pour applications portables – Partie 3: Eléments et batteries d'accumulateurs au lithium, parallélépipédiques et cylindriques



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## NORME INTERNATIONALE

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## SECONDARY CELLS AND BATTERIES CONTAINING ALKALINE OR OTHER NON-ACID ELECTROLYTES – SECONDARY LITHIUM CELLS AND BATTERIES FOR PORTABLE APPLICATIONS –

### Part 3: Prismatic and cylindrical lithium secondary cells, and batteries made from them

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International Standard IEC 61960-3 has been prepared by subcommittee 21A: Secondary cells and batteries containing alkaline or other non-acid electrolytes, of IEC technical committee 21: Secondary cells and batteries.

This first edition cancels and replaces the second edition of IEC 61960 published in 2011. It is a technical revision.

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

- adding definition of portable applications (Scope),
- update of examples of cells (Table 1 and 2),

- adding “Dimensions of the cell with a laminate film case” (Annex A),
- adding “Capacity after storage” (from the date of manufacture) (Annex B).

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

FDIS	Report on voting
21A/618/FDIS	21A/625/RVD

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

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

A list of all parts in the IEC 61960 series, published under the general title *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for portable applications*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

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# SECONDARY CELLS AND BATTERIES CONTAINING ALKALINE OR OTHER NON-ACID ELECTROLYTES – SECONDARY LITHIUM CELLS AND BATTERIES FOR PORTABLE APPLICATIONS –

## Part 3: Prismatic and cylindrical lithium secondary cells, and batteries made from them

### 1 Scope

This part of IEC 61960 specifies performance tests, designations, markings, dimensions and other requirements for secondary lithium single cells and batteries for portable applications.

The objective of this document is to provide the purchasers and users of secondary lithium cells and batteries with a set of criteria with which they can judge the performance of secondary lithium cells and batteries offered by various manufacturers.

Portable applications comprise hand-held equipment, transportable equipment and movable equipment.

Examples of the main uses are shown below:

- a) hand-held equipment: smartphone, tablet, PCs, audio/video players, and similar equipment;
- b) transportable equipment: notebook computers, CD players, and similar equipment;
- c) movable equipment:
  - 18 kg or less in mass and not fixed in place, or
  - provided with wheels, castors, or other means to facilitate movement by an ordinary person as required to perform its intended use,
  - power tools, power assisted cycles, business-use video cameras, and similar equipment.

NOTE 1 All applications using batteries whose nominal voltages are equal to or over the hazardous voltage of 60 V DC are excluded.

NOTE 2 EESS (Electrical Energy Storage Systems) and UPS, which use batteries over 500 Wh of electric energy are excluded.

NOTE 3 Self-propelled vehicles are excluded.

This document defines a minimum required level of performance and a standardized methodology by which testing is performed and the results of this testing reported to the user. Hence, users will be able to establish the viability of commercially available cells and batteries via the declared specification and thus be able to select the cell or battery best suited for their intended application. The end user can handle only batteries which have completely fulfilled all the requirements of this document and others concerning safety such as IEC 62133-2.

This document covers secondary lithium cells and batteries with a range of chemistries. Each electrochemical couple has a characteristic voltage range over which it releases its electrical capacity, a characteristic nominal voltage and a characteristic final voltage during discharge. Users of secondary lithium cells and batteries are requested to consult the manufacturer for advice.



## 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 60050-482:2004, *International Electrotechnical Vocabulary (IEV) – Part 482: Primary and secondary cells and batteries*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 62133-2:2017, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells and for batteries made from them, for use in portable applications – Part 2: Lithium systems*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-482 and the following apply.

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

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

### 3.1

#### **charge recovery**

#### **capacity recovery**

capacity that a cell or battery can deliver with subsequent recharge after storage, at a specific temperature, for a specific time, as a percentage of the rated capacity

### 3.2

#### **charge retention**

#### **capacity retention**

capacity that a cell or battery can deliver after storage, at a specific temperature, for a specific time without subsequent recharge as a percentage of the rated capacity

### 3.3

#### **final voltage**

#### **end-of-discharge voltage**

specified closed circuit voltage at which a discharge of a cell or battery is terminated

### 3.4

#### **nominal voltage**

suitable approximate value of the voltage used to designate or identify a cell, a battery or an electrochemical system

Note 1 to entry: The nominal voltages of secondary lithium cells are shown in Table 1 and 2.

Note 2 to entry: The nominal voltage of a battery of  $n$  series connected cells is equal to  $n$  times the nominal voltage of a single cell.

[SOURCE: IEC 60050-482:2004, 482-03-31, modified – Addition Notes 1 and 2 to entry.]

**3.5****rated capacity**

capacity value of a cell or battery determined under specified conditions and declared by the manufacturer

Note 1 to entry: The rated capacity is the quantity of electricity  $C_5$  Ah (ampere-hours) declared by the manufacturer which a single cell can deliver during a 5-h period, when charged, stored and discharged under the conditions specified in 7.3.1

[SOURCE: IEC 60050-482:2004, 482-03-15, modified – Addition of Note 1 to entry.]

**3.6****secondary lithium battery**

unit which incorporates one or more secondary lithium cells and which is ready for use

Note 1 to entry: It may incorporate adequate housing and a terminal arrangement and may have electronic control devices.

**3.7****secondary lithium cell**

secondary cell where electrical energy is derived from the insertion/extraction reactions of lithium ions or oxidation/reduction reaction of lithium between the negative electrode and the positive electrode

Note 1 to entry: The cell typically has an electrolyte that consists of a lithium salt and organic solvent compound in liquid, gel or solid form and has a metal or a laminate film casing. It is not ready for use in an application because it is not yet fitted with its final housing, terminal arrangement and electronic control device.

**3.8****lithium ion polymer cell**

cell using gel polymer electrolyte or solid polymer electrolyte, not liquid electrolyte

**4 Parameter measurement tolerances**

The overall accuracy of controlled or measured values, relative to the specified or actual values, shall be within the following tolerances:

- a)  $\pm 1 \%$  for voltage;
- b)  $\pm 1 \%$  for current;
- c)  $\pm 1 \%$  for capacity;
- d)  $\pm 2 \text{ }^{\circ}\text{C}$  for temperature;
- e)  $\pm 0,1 \%$  for time;
- f)  $\pm 0,1 \text{ mm}$  for dimensions.

These tolerances comprise the combined accuracy of the measuring instruments, the measurement techniques used, and all other sources of error in the test procedure.

The details of the instrumentation used shall be provided in any report of results.

**5 Cell designation and marking****5.1 Cell and battery designation**

Batteries shall be designated with following form:

$$N_1 A_1 A_2 A_3 N_2 / N_3 / N_4 - N_5$$

Cells shall be designated with following form:

$$A_1 A_2 A_3 N_2 / N_3 / N_4$$

where

$N_1$  is the number of series connected cells in the battery;

$A_1$  designates the negative electrode basis in which

I is carbon;

L is lithium metal or lithium alloy;

T is titanium;

X is others;

$A_2$  designates the positive electrode basis in which

C is cobalt;

F is iron;

Fp is iron phosphate;

N is nickel;

M is manganese;

Mp is manganese phosphate;

T is titanium;

V is vanadium;

X is others;

$A_3$  designates the shape of the cell in which

R is cylindrical;

P is prismatic;

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$N_2$  is the maximum diameter (if R) or the maximum thickness (if P) in millimetres rounded up to the next whole number;

$N_3$  is the maximum width (if P) in millimetres rounded up to the next whole number ( $N_3$  not shown if R);

$N_4$  is the maximum overall height in millimetres rounded up to the next whole number;

NOTE 1 If any dimension is less than 1 mm, the units used are tenths of millimetres and the single number is written tN.

$N_5$  is the number of parallel connected cells if two or more (not shown if value is 1).

EXAMPLE 1 ICR19/66 designates a cylindrical Li-ion secondary cell, with a cobalt-based positive electrode, a maximum diameter which is greater than 18 mm and less than or equal to 19 mm, a maximum overall height which is greater than 65 mm and less than or equal to 66 mm.

EXAMPLE 2 ICP9/35/150 designates a prismatic Li-ion secondary lithium cell, with a cobalt-based positive electrode, a maximum thickness which is greater than 8 mm and less than or equal to 9 mm, a maximum width which is greater than 34 mm and less than or equal to 35 mm, and a maximum overall height which is greater than 149 mm and less than or equal to 150 mm.

EXAMPLE 3 ICPT9/35/48 designates a prismatic Li-ion secondary lithium cell, with a cobalt-based positive electrode, a maximum thickness which is greater than 0,8 mm and less than or equal to 0,9 mm, a maximum width which is greater than 34 mm and less than or equal to 35 mm, and a maximum overall height which is greater than 47 mm and less than or equal to 48 mm.

EXAMPLE 4 1ICR20/70 designates a cylindrical Li-ion secondary battery with one single cell, a cobalt-based positive electrode, a maximum diameter which is greater than 19 mm and less than or equal to 20 mm, and a maximum overall height which is greater than 69 mm and less than or equal to 70 mm.

EXAMPLE 5 2ICP20/34/70 designates a prismatic Li-ion secondary battery with two series connected cells, a cobalt-based positive electrode, a maximum thickness which is greater than 19 mm and less than or equal to 20 mm, a maximum width which is greater than 33 mm and less than or equal to 34 mm, and a maximum overall height which is greater than 69 mm and less than or equal to 70 mm.

EXAMPLE 6 1ICP20/68/70-2 designates a prismatic Li-ion secondary battery with two parallel connected cells, a cobalt-based positive electrode, a maximum thickness which is greater than 19 mm and less than or equal to 20 mm, a maximum width which is greater than 67 mm and less than or equal to 68 mm, and a maximum overall height which is greater than 69 mm and less than or equal to 70 mm.

EXAMPLE 7 When the batteries which have different designation such as ICR19/66 and ICP9/35/150 are parallel connected into single case, the marking to the case is taken as (ICR19/66)(ICP9/35/150).

NOTE 2 Notwithstanding the above specification, other designations can be used according to agreement between manufacturer and user.

## 5.2 Marking

Each cell or battery shall carry clear and durable markings giving the following information:

Manufacturer shall provide the following information in document form such as specification sheet or instruction manual or similar documents. When the battery is handled by end-users, the following information shall be marked on it.

- secondary (rechargeable) Li or Li-ion;
- battery or cell designation as specified in 5.1;
- polarity;
- date of manufacture (which may be in code);
- name or identification of manufacturer or supplier;
- rated capacity;
- nominal voltage.

When a cell or battery is considered swallowable the following additional information shall be marked on it or on the immediate package:

- caution for batteries which are considered swallowable (see IEC 60086-4).

When the battery surface is too small to accommodate all markings, information shall be given in specification sheet or in instruction manual or on the immediate package instead of on the battery.

Polarity need not be marked when the battery has been exclusively designed not to be connected wrongly.

Instead of designation as specified in 5.1, product code or name of battery can be used when the battery is designed for use in particular end product.

By agreement between the cell manufacturer and battery and/or end product manufacturer, cells used in the assembly of a battery need not be marked. The battery designed not to be replaced by the end user also need not be marked.

## 5.3 Providing the design and produce requirement of batteries

In order to ensure the safe use of lithium-ion secondary batteries, cell manufacturers shall provide equipment manufacturers who design and produce lithium-ion secondary batteries with the requirements specified in IEC 62133-2:2017, Annex A.

## 6 Examples of cells

Table 1 shows the specifications of some secondary lithium cell(s), and Table 2 shows the chemistries of the secondary lithium cell(s) that are suitable for standardization and used in assembling batteries.

**Table 1 – Specification examples of secondary lithium cells for portable applications**

	Cylindrical	Prismatic (metal case)	Prismatic (laminate film case)
Secondary lithium cell	ICR19/66	ICP5/34/50	ICP7/34/50
Height (mm)	64,0/65,2	49,0/49,6	49,2/50,0
Diameter (mm)	17,8/18,5	NA	NA
Width (mm)	NA	33,6/34,0	33,2/34,0
Thickness (mm)	NA	4,1/4,6	6,2/7,0
Nominal voltage (V)	3,7	3,7	3,7
Final voltage (V)	2,50	2,50	2,50
Final voltage (V) for endurance (cycle life)	2,75	2,75	2,75

**Table 2 – Examples of secondary lithium cells for portable applications**

Cell type	Positive electrode	Electrolyte	Negative electrode	Cell case	Nominal Voltage (V)
Lithium ion	Lithium transition metal (Nickel, Cobalt, Manganese) oxide	Non-aqueous solution with lithium salt	Carbon	Metal	3,6~3,9
				Laminate film	
			Tin based Compound	Metal	3,3~3,6
			Titanium oxide	Metal	2,2~2,5
			Laminate film		
	Lithium iron phosphate		Carbon	Metal	3,2
		Laminate film			
Lithium ion polymer	Lithium transition metal (Nickel, Cobalt, Manganese) oxide	Gel polymer with lithium salt	Carbon	Laminate film	3,6~3,8

NOTE A lithium ion cell is a secondary cell. The electrode materials are selected so that lithium metal is not involved in the charge and the discharge directly. Typical examples of lithium ion cells are listed in this table.

## 7 Electrical tests

### 7.1 General

Only cell or battery samples which are less than two months (60 days) old, from the date of manufacture, shall be used for the tests specified in this document.

NOTE Generally capacity of lithium ion cells or batteries gradually decreases (see Table B.1).

Charge and discharge currents for the tests shall be based on the value of the rated capacity ( $C_5$  Ah). These currents are expressed as a multiple of  $I_t$  A, where:  $I_t$  A =  $C_5$  Ah/1 h.

The minimum values required for each electrical test are stated in Table 5. Sample sizes and sequence of tests are described in Figure 1.

## 7.2 Charging procedure for test purposes

Prior to charging, the cell or battery shall be discharged at  $20\text{ °C} \pm 5\text{ °C}$  at a constant current of  $0,2 I_t$  A, down to a specified final voltage.

Unless otherwise stated in this document, cells or batteries shall be charged, in an ambient temperature of  $20\text{ °C} \pm 5\text{ °C}$ , using the method declared by the manufacturer.

## 7.3 Discharge performance

### 7.3.1 Discharge performance at $20\text{ °C}$ (rated capacity)

This test verifies the rated capacity of a cell or battery.

Step 1 – The cell or battery shall be charged in accordance with 7.2.

Step 2 – The cell or battery shall be stored, in an ambient temperature of  $20\text{ °C} \pm 5\text{ °C}$ , for not less than 1 h and not more than 4 h.

Step 3 – The cell or battery shall be discharged, in an ambient temperature of  $20\text{ °C} \pm 5\text{ °C}$ , at a constant current of  $0,2 I_t$  A, until its voltage is equal to the specified final voltage.

Step 4 – The capacity (Ah) delivered during step 3 shall be not less than 100 % of the rated capacity declared by the manufacturer. Steps 1 to 4 may be repeated up to four additional times, as necessary to satisfy this requirement.

### 7.3.2 Discharge performance at $-20\text{ °C}$

This test determines the capacity of the cell or battery at low temperature.

Step 1 – The cell or battery shall be charged in accordance with 7.2.

Step 2 – The cell or battery shall be stored, in an ambient temperature of  $-20\text{ °C} \pm 2\text{ °C}$ , for not less than 16 h and not more than 24 h.

Step 3 – The cell or battery shall be discharged, in an ambient temperature of  $-20\text{ °C} \pm 2\text{ °C}$ , at a constant current of  $0,2 I_t$  A, until its voltage is equal to the specified final voltage.

Step 4 – The capacity (Ah), delivered during step 3, shall be not less than that specified for this characteristic in Table 5.

### 7.3.3 High rate discharge performance at $20\text{ °C}$

This test determines the capacity of a cell or battery when discharged at a high rate. This test is not required if the cell or battery is not designed to be used at this rate.

Step 1 – The cell or battery shall be charged in accordance with 7.2.

Step 2 – The cell or battery shall be stored, in an ambient temperature of  $20\text{ °C} \pm 5\text{ °C}$ , for not less than 1 h and not more than 4 h.

Step 3 – The cell or battery shall be discharged, in an ambient temperature of  $20\text{ °C} \pm 5\text{ °C}$ , at a constant current of  $1,0 I_t$  A, until its voltage is equal to the specified final voltage.

Step 4 – The capacity (Ah) delivered during step 3 shall be not less than that specified for this characteristic in Table 5.

#### 7.4 Charge (capacity) retention and recovery

This test determines firstly the capacity which a cell or battery retains after storage for an extended period of time, and secondly the capacity that can be recovered by a subsequent recharge.

Step 1 – The cell or battery shall be charged in accordance with 7.2.

Step 2 – The cell or battery shall be stored in an ambient temperature of  $20\text{ °C} \pm 5\text{ °C}$ , for 28 days.

Step 3 – The cell or battery shall be discharged, in an ambient temperature of  $20\text{ °C} \pm 5\text{ °C}$ , at a constant current of  $0,2 I_t$  A, until its voltage is equal to the specified final voltage.

Step 4 – The 28-day retained capacity (Ah) delivered, during step 3, shall be not less than that specified for this characteristic in Table 5.

Step 5 – The cell or battery shall then be charged in accordance with 7.2, within 24 h following the discharge of step 3.

Step 6 – The cell or battery shall be stored, in an ambient temperature of  $20\text{ °C} \pm 5\text{ °C}$ , for not less than 1 h and not more than 4 h.

Step 7 – The cell or battery shall be discharged, in an ambient temperature of  $20\text{ °C} \pm 5\text{ °C}$ , at a constant current of  $0,2 I_t$  A, until its voltage is equal to the specified final voltage.

Step 8 – The recovery capacity (Ah) delivered, during step 7, shall be not less than that specified for this characteristic in Table 5.

#### 7.5 Charge (capacity) recovery after long term storage

This test determines the capacity of a cell or battery after extended storage at 50 % state of charge, followed by a subsequent charge.

Step 1 – The cell or battery shall be charged in accordance with 7.2.

Step 2 – The cell or battery shall be discharged, in an ambient temperature of  $20\text{ °C} \pm 5\text{ °C}$ , at a constant current of  $0,2 I_t$  A, for 2,5 h.

Step 3 – The cell or battery shall be stored in an ambient temperature of  $40\text{ °C} \pm 2\text{ °C}$ , for 90 days.

Step 4 – The cell or battery shall be charged, in an ambient temperature of  $20\text{ °C} \pm 5\text{ °C}$ , using the method declared by the manufacturer.

Step 5 – The cell or battery shall be stored, in an ambient temperature of  $20\text{ °C} \pm 5\text{ °C}$ , for not less than 1 h and not more than 4 h.

Step 6 – The cell or battery shall be discharged, in an ambient temperature of  $20\text{ °C} \pm 5\text{ °C}$ , at a constant current of  $0,2 I_t$  A, until its voltage is equal to the specified final voltage.

Step 7 – The capacity (Ah) delivered during step 6 shall be not less than that specified for this characteristic in Table 5. Steps 4, 5 and 6 may be repeated up to four additional times, as necessary to satisfy this requirement.