IEC 62660-1

Edition 2.0 2018-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Secondary lithium-ion cells for the propulsion of electric road vehicles – Part 1: Performance testing

Éléments d'accumulateurs lithium-ion pour la propulsion des véhicules routiers électriques – Partie 1: Essais de performance

IEC 62660-1:2018-12(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 29.220.20; 43.120

ISBN 978-2-8322-6288-7

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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SECONDARY LITHIUM-ION CELLS FOR THE PROPULSION OF ELECTRIC ROAD VEHICLES –

Part 1: Performance testing

FOREWORD

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International Standard IEC 62660-1 has been prepared by IEC technical committee 21: Secondary cells and batteries.

This second edition cancels and replaces the first edition published in 2010. This edition constitutes a technical revision.

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

a) The purpose of each test has been added.
b) The power test has been revised for clarification, and an informative part of the current-voltage characteristic test has been moved to the new Annex C.

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

FDIS	Report on voting
21/975/FDIS	21/985/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 the parts in the IEC 62660 series, published under the general title *Secondary lithium-ion cells for the propulsion of electric road vehicles*, 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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

The commercialization of electric road vehicles including battery, hybrid and plug-in hybrid electric vehicles has been accelerated in the global market, responding to the global concerns on CO_2 reduction and energy security. This, in turn, has led to rapidly increasing demand for high-power and high-energy-density traction batteries. Lithium-ion batteries are estimated to be one of the most promising secondary batteries for the propulsion of electric vehicles. In the light of the rapid spread of hybrid electric vehicles and the emergence of battery and plug-in hybrid electric vehicles, a standard method for testing performance requirements of lithium-ion batteries is indispensable for securing a basic level of performance and obtaining essential data for the design of vehicle systems and battery packs.

This document specifies performance testing for automobile traction lithium-ion cells that basically differ from the other cells including those for portable and stationary applications specified by other IEC standards. For automobile application, it is important to note the usage specificity; i.e. the design diversity of automobile battery packs and systems, and specific requirements for cells and batteries corresponding to each of such designs. Based on these facts, the purpose of this document is to provide a basic test methodology with general versatility, which serves a function in common primary testing of lithium-ion cells to be used in a variety of battery systems.

This document is associated with ISO 12405-4 [1][1].

IEC 62660-2 [2] specifies the reliability and abuse testing for lithium-ion cells for electric vehicle application.

IEC 62660-3 [3] specifies the safety requirements of lithium-ion cells for electric vehicle application.

1 Numbers in square brackets refer to the Bibliography.

SECONDARY LITHIUM-ION CELLS FOR THE PROPULSION OF ELECTRIC ROAD VEHICLES –

Part 1: Performance testing

1 Scope

This part of IEC 62660 specifies performance and life testing of secondary lithium-ion cells used for propulsion of electric vehicles including battery electric vehicles (BEV) and hybrid electric vehicles (HEV).

NOTE 1 Secondary lithium-ion cell used for propulsion of plug-in hybrid electric vehicle (PHEV) can be tested by the procedure either for BEV application or HEV application, according to the battery system design, based on the agreement between the cell manufacturer and the customer.

This document specifies the test procedures to obtain the essential characteristics of lithium-ion cells for vehicle propulsion applications regarding capacity, power density, energy density, storage life and cycle life.

This document provides the standard test procedures and conditions for testing basic performance characteristics of lithium-ion cells for vehicle propulsion applications, which are indispensable for securing a basic level of performance and obtaining essential data on cells for various designs of battery systems and battery packs.

NOTE 2 Based on the agreement between the cell manufacturer and the customer, specific test conditions can be selected in addition to the conditions specified in this document. Selective test conditions are described in Annex A.

NOTE 3 The performance tests for the electrically connected lithium-ion cells can be performed with reference to this document.

NOTE 4 The test specification for lithium-ion battery packs and systems is defined in ISO 12405-4 [1].

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.

ISO/TR 8713, *Electrically propelled road vehicles – Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TR 8713 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
battery electric vehicle
BEV
electric vehicle with only a traction battery as power source for vehicle propulsion

3.2
hybrid electric vehicle
HEV
vehicle with both a rechargeable energy storage system and a fuelled power source for propulsion

3.3
rated capacity
C_n
capacity value of a cell in ampere hours (Ah) determined under specified conditions and declared by the cell manufacturer

Note 1 to entry: n in C_n is the time base in hours (h). In this document, n = 3 for BEV application and n = 1 for HEV application unless otherwise specified.

3.4
I_t
reference test current in amperes (A) which is expressed as

$I_t = C_n/1$

Note 1 to entry: 1 has a dimension of time in hours (h).

Note 2 to entry: See IEC 61434:1996 [4], Clause 2.

3.5
room temperature
temperature of 25 °C ± 2 K

3.6
secondary lithium-ion cell
cell
secondary single cell whose electric energy is derived from the insertion and extraction reactions of lithium ions between the anode and the cathode

Note 1 to entry: The secondary lithium-ion cell is a basic manufactured unit providing a source of electric energy by direct conversion of chemical energy. It consists of electrodes, separators, electrolyte, container and terminals, and is designed to be charged electrically.

3.7
state of charge
SOC
capacity in a cell expressed as a percentage of rated capacity

3.8
charge retention
ability of a cell to retain capacity on open circuit under specified conditions of storage

4 Test conditions

4.1 General

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

Test and measurement shall be conducted with caution to prevent a short circuit.

NOTE Test and measurement can be conducted under fixing condition recommended by the cell manufacturer.

4.2 Measuring instruments

4.2.1 Range of measuring devices

The instruments used shall enable the values of voltage, current and temperature to be measured. The range of these instruments and measuring methods shall be chosen so as to ensure the accuracy specified for each test.

For analogue instruments, this implies that the readings shall be taken in the last third of the graduated scale.

Any other measuring instruments may be used provided they give an equivalent accuracy.

4.2.2 Voltage measurement

The resistance of the voltmeters used shall be at least 1 MΩ/V.

4.2.3 Current measurement

The entire assembly of ammeter, shunt and leads shall be of an accuracy class of 0,5 or better.

4.2.4 Temperature measurements

The cell temperature shall be measured by use of a surface temperature measuring device capable of an equivalent scale definition and accuracy of calibration as specified in 4.2.1. The temperature shall be measured at a location which most closely reflects the cell temperature. The temperature may be measured at additional appropriate locations, if necessary.

The examples for temperature measurement are shown in Figure 1. The instructions for temperature measurement specified by the cell manufacturer shall be followed.

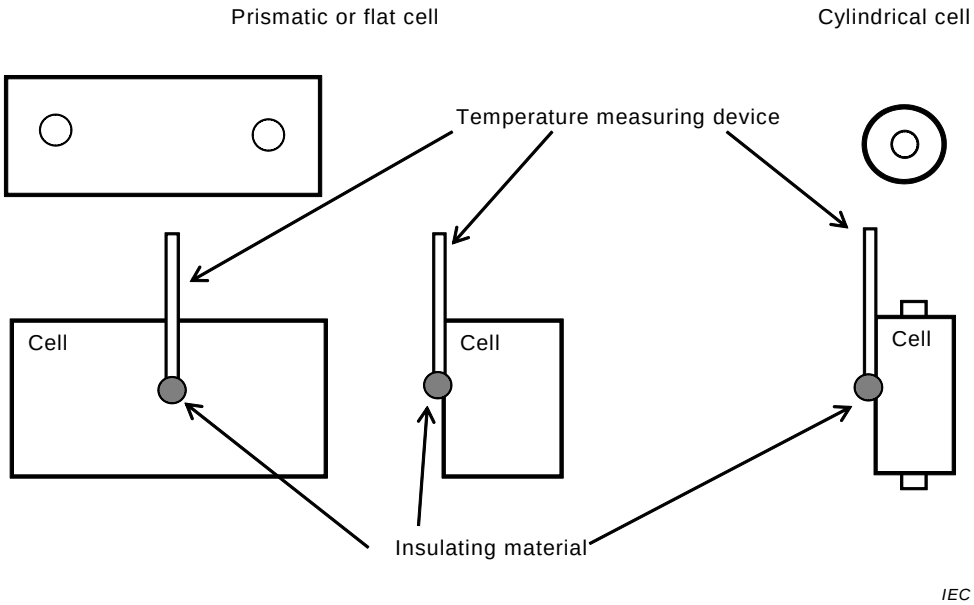

Figure 1 – Example of temperature measurement of cell

4.2.5 Other measurements

Other values may be measured by use of a measuring device, provided that it complies with 4.3.

4.3 Tolerance

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

a) ± 0,1 % for voltage;

b) ± 1 % for current;

c) ± 2 K for temperature;

d) ± 0,1 % for time;

e) ± 0,1 % for mass;

f) ± 0,1 % for dimensions.

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

4.4 Thermal stabilization

For the stablization of cell temperature, the cell shall be soaked to a specified ambient temperature for a minimum of 12 h. This period may be reduced if thermal stabilization is reached. Thermal stabilization is considered to be reached if after one interval of 1 h, the change of cell temperature is lower than 1 K.

5 Dimension measurement

The maximum dimension of the total width, thickness or diameter, and height of a cell shall be measured at room temperature up to three significant figures in accordance with the tolerances in 4.3.

Examples of maximum dimensions are shown in Figures 2a to 2f.

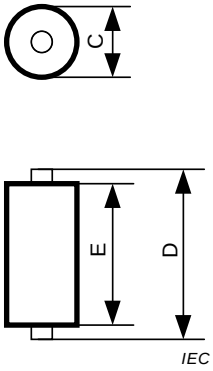

Figure 2a – Cylindrical cell (1)

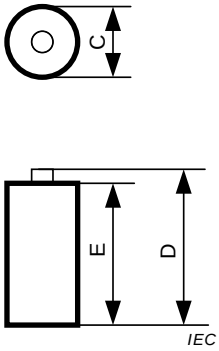

Figure 2b – Cylindrical cell (2)

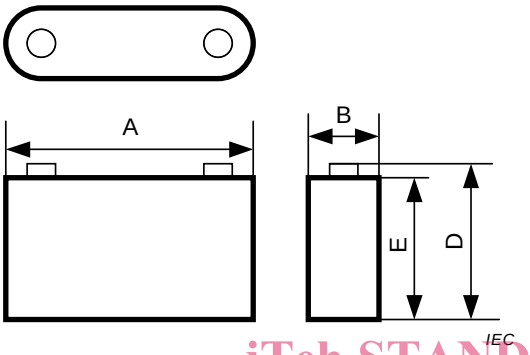

Figure 2c – Prismatic cell (1)

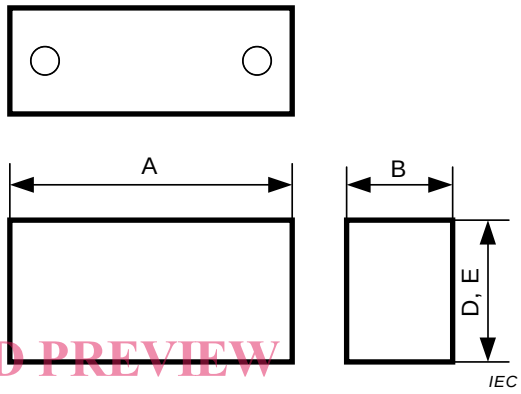

Figure 2d – Prismatic cell (2)

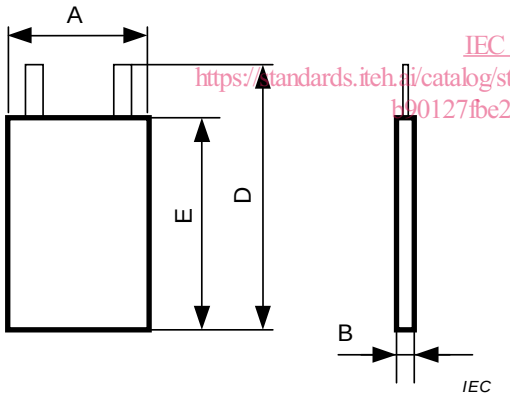

Figure 2e – Prismatic cell with laminate film case (1)

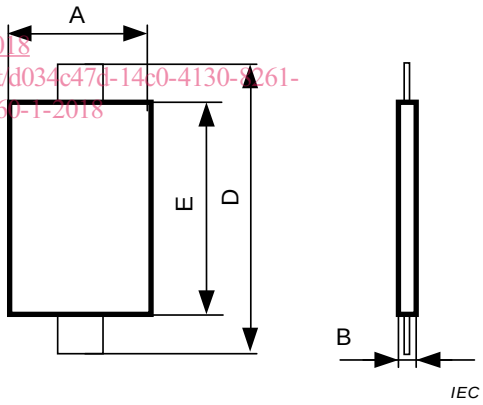

Figure 2f – Prismatic cell with laminate film case (2)

Key

A total width
B total thickness
C diameter
D total height (including terminals)
E total height (excluding terminals)

Figure 2 – Examples of maximum dimensions of cell

NOTE Prismatic cells are provided with either a rigid metal case or flexible laminate film case. A prismatic cell with laminate film case is usually called a pouch cell.

The volume of a prismatic cell is given by the product of its total height excluding terminals, total width, and total thickness, and that of a cylindrical cell is given by the product of the cross section of the cylinder and its total height excluding terminals.

6 Mass measurement

The mass of a cell is measured at room temperature up to three significant figures in accordance with the tolerances in 4.3.

7 Electrical measurement

7.1 General

During each test, voltage, current and temperature shall be recorded.

Before each test, the cell temperature shall be stabilized at room temperature according to 4.4, unless otherwise specified.

The ambient temperature shall be the room temperature unless otherwise specified.

7.2 General charge conditions

Unless otherwise stated in this document, prior to electrical measurement test, the cell shall be charged as follows.

Prior to charging, the cell shall be discharged at room temperature at a constant current described in Table 1 down to an end-of-discharge voltage specified by the cell manufacturer. Then, the cell shall be charged at room temperature according to the charging method declared by the cell manufacturer.

7.3 Capacity

The capacity of a cell shall be measured in accordance with the following phases.

Phase 1 – The cell shall be charged in accordance with 7.2.

After recharge, the cell temperature shall be stabilized in accordance with 4.4.

Phase 2 – The cell shall be discharged at specified temperature at a constant current I_t (A) to the end-of-discharge voltage that is provided by the cell manufacturer. The discharge current and cell temperatures indicated in Table 1 shall be used.

In addition to Table 1, specific test conditions may be selected based on the agreement between the cell manufacturer and the customer. Selective test conditions are shown in Table A.1.

Table 1 – Discharge conditions

<table>
<tr><th rowspan="2">Cell temperature
°C</th><th colspan="2">Discharge current
A</th></tr>
<tr><th>BEV application</th><th>HEV application</th></tr>
<tr><td>0</td><td rowspan="3">1/3 I_t</td><td rowspan="3">1 I_t</td></tr>
<tr><td>25</td></tr>
<tr><td>45</td></tr>
</table>

Phase 3 – Measure the discharge duration until the specified end-of-discharge voltage is reached. Calculate the capacity of cell expressed in Ah up to three significant figures, by multiplying the discharge current (A) with the discharge duration (h).

7.4 SOC adjustment

The test cells shall be charged as specified below, unless otherwise specified. The SOC adjustment is the procedure to be followed for preparing cells to the various SOCs for the tests in this document.

Phase 1 – The cell shall be charged in accordance with 7.2.

Phase 2 – The cell shall be left at rest at room temperature in accordance with 4.4.

Phase 3 – The cell shall be discharged at a constant current according to Table 1 for $(100 - n)/100 \times 3$ h for BEV application and $(100 - n)/100 \times 1$ h for HEV application, where n is SOC (%) to be adjusted for each test.

7.5 Power

7.5.1 General

This test is intended to determine the power characteristics of a cell under the representative usage conditions of BEV and HEV applications.

Based on the current-voltage characteristic test in 7.5.2, the power density and regenerative power density of a cell shall be calculated according to 7.5.3 and 7.5.4, respectively.

The power density and regenerative power density shall be calculated and reported for each combination of SOC and temperature in 7.5.2.

7.5.2 Test method

The test shall be carried out in accordance with the following procedure.

a) Mass measurement

Mass of the cell shall be measured as specified in Clause 6.

b) Dimension measurement

Dimensions of the cell shall be measured as specified in Clause 5.

c) SOC and temperature adjustment

The test in 7.5.2 d) shall be conducted under each combination of SOC and cell temperature at the test commencement as specified in Table 2, according to the procedure specified by the cell manufacturer.

SOC shall be adjusted according to 7.4.

Table 2 – SOC and temperature condition for power test

SOC %	Cell temperature °C			
20	25			
50	−20	0	25	40
80	25			

NOTE Selective test conditions are shown in Table A.2.

d) Current-voltage characteristics test

Discharge the cell for 10 s at the maximum current for discharge specified by the cell manufacturer (I_{dmax}), and measure the voltage at the end of the 10 s pulse (U_d).