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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SECONDARY LITHIUM-ION CELLS FOR
THE PROPULSION OF ELECTRIC ROAD VEHICLES –****Part 1: Performance testing**

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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- withdrawn,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.

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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 CO₂ 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 ~~rapidly diffusing~~ 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 12405-1 and ISO 12405-2~~¹ ISO 12405-4 [1]².

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.

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¹ ~~Under consideration.~~

² 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 ~~may~~ 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 ~~may~~ can be performed with reference to this document.

NOTE 4 The test specification for lithium-ion battery packs and systems is defined in ~~ISO 12405-1 and ISO 12405-2 (under consideration)~~ 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.

~~IEC 60050-482, International Electrotechnical Vocabulary – Part 482: Primary and secondary cells and batteries~~

~~IEC 61434, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Guide to the designation of current in alkaline secondary cell and battery standards~~

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ~~IEC 60050-482~~ 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
quantity of electricity C_3 Ah (ampere-hours) for BEV and C_1 Ah for HEV declared by the manufacturer~~

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
reference test current**

~~I_t
current in amperes which is expressed as~~

~~$I_t \text{ (A)} = C_n \text{ (Ah)} / 1 \text{ (h)}$~~

~~where~~

~~C_n is the rated capacity of the cell;~~

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 $25 \text{ }^\circ\text{C} \pm 2 \text{ K}$

**3.6
secondary lithium-ion cell
cell**

secondary single cell whose electrical 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 electrical energy by direct conversion of chemical energy. It consists of electrodes, separators, electrolyte, container and terminals, and is designed to be charged electrically.

~~NOTE 2 In this standard, cell or secondary cell means the secondary lithium ion cell to be used for the propulsion of electric road vehicles.~~

3.7

state of charge

SOC

~~available~~ capacity in a ~~battery~~ 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 M Ω /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 ~~should~~ 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.

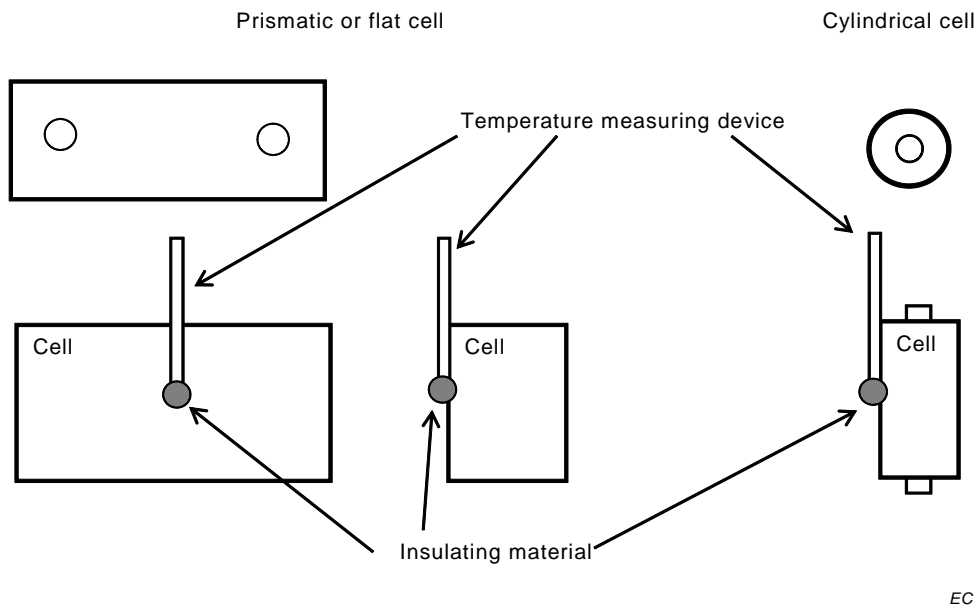


Figure 1 – Example of temperature measurement of cell

4.2.5 Other measurements

Other values ~~including capacity and power~~ 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) $\pm 0,1$ % for voltage;
- b) ± 1 % for current;
- c) ± 2 K for temperature;
- d) $\pm 0,1$ % for time;
- e) $\pm 0,1$ % for mass;
- f) $\pm 0,1$ % 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 Test temperature~~

~~If not otherwise defined, before each test the cell shall be stabilized at the test temperature for a minimum of 12 h. This period can 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.~~

~~Unless otherwise stated in this standard, cells shall be tested at room temperature using the method declared by the manufacturer.~~

4.4 Thermal stabilization

For the stabilization 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

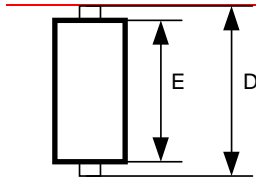
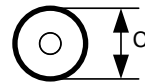
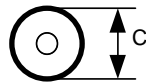
The maximum dimension of the total width, thickness or diameter, and ~~length~~ height of a cell shall be measured at room temperature up to three significant figures in accordance with the tolerances in 4.3.

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

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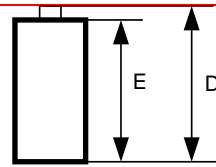
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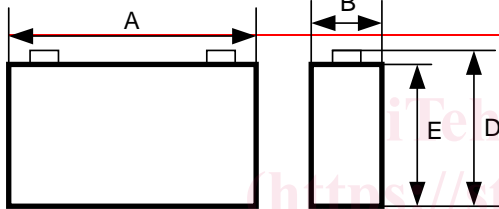
IEC 2862/10

Figure 2a – Cylindrical cell (1)



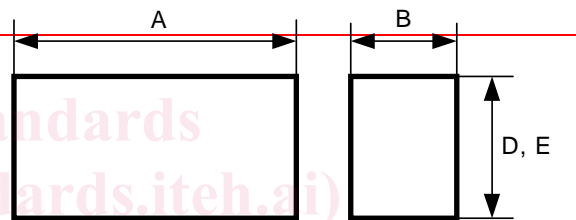
IEC 2863/10

Figure 2b – Cylindrical cell (2)



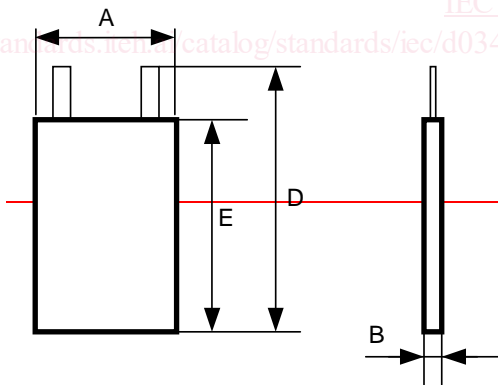
IEC 2864/10

Figure 2c – Prismatic cell (1)



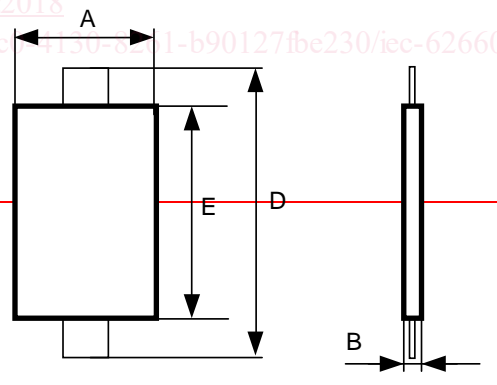
IEC 2865/10

Figure 2d – Prismatic cell (2)



IEC 2866/10

Figure 2e – Flat cell (1)



IEC 2867/10

Figure 2f – Flat cell (2)

Key

A—total width

B—total thickness

C—diameter

D—total length (including terminals)

E—total length (excluding terminals)