

BS EN 62660-1:2011



BSI Standards Publication

Secondary lithium-ion cells for the propulsion of electric road vehicles

Part 1: Performance testing

bsi.

...making excellence a habit.
AVA Documents™
Document Sharing Hub

National foreword

This British Standard is the UK implementation of EN 62660-1:2011. It is identical to IEC 62660-1:2010.

The UK participation in its preparation was entrusted to Technical Committee PEL/21, Secondary cells and batteries.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© BSI 2011

ISBN 978 0 580 70045 3

ICS 29.220.20; 43.120

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 September 2011.

Amendments issued since publication

Amd. No.	Date	Text affected
----------	------	---------------

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 62660-1

July 2011

ICS 29.220.20; 43.120

English version

Secondary lithium-ion cells for the propulsion of electric road vehicles - Part 1: Performance testing (IEC 62660-1:2010)

Eléments d'accumulateurs lithium-ion pour
la propulsion des véhicules routiers
électriques -
Partie 1: Essais de performance
(CEI 62660-1:2010)

Lithium-Ionen-Sekundärzellen für den
Antrieb von Elektrostraßenfahrzeugen -
Teil 1: Prüfung des Leistungsverhaltens
(IEC 62660-1:2010)

This European Standard was approved by CENELEC on 2011-01-20. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Management Centre: Avenue Marnix 17, B - 1000 Brussels

© 2011 CENELEC - All rights of exploitation in any form and by any means reserved worldwide for CENELEC members.

Ref. No. EN 62660-1:2011 E

 **Documents**
Document Sharing Hub

Foreword

The text of document 21/728/FDIS, future edition 1 of IEC 62660-1, prepared by IEC TC 21, Secondary cells and batteries, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 62660-1 on 2011-01-20.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2011-10-20 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2014-01-20 |

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62660-1:2010 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 62660-2	NOTE	Harmonized as EN 62660-2.
-------------	------	---------------------------

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
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	EN 61434	-

CONTENTS

INTRODUCTION	6
1 Scope.....	7
2 Normative references.....	7
3 Terms and definitions.....	7
4 Test conditions.....	8
4.1 General.....	8
4.2 Measuring instruments.....	8
4.2.1 Range of measuring devices	8
4.2.2 Voltage measurement.....	9
4.2.3 Current measurement.....	9
4.2.4 Temperature measurements.....	9
4.2.5 Other measurements	9
4.3 Tolerance.....	10
4.4 Test temperature.....	10
5 Dimension measurement	10
6 Mass measurement.....	11
7 Electrical measurement.....	11
7.1 General charge conditions	11
7.2 Capacity.....	12
7.3 SOC adjustment.....	12
7.4 Power	12
7.4.1 Test method	12
7.4.2 Calculation of power density.....	15
7.4.3 Calculation of regenerative power density.....	16
7.5 Energy	17
7.5.1 Test method	17
7.5.2 Calculation of energy density.....	17
7.6 Storage test.....	18
7.6.1 Charge retention test.....	18
7.6.2 Storage life test	19
7.7 Cycle life test.....	19
7.7.1 BEV cycle test	19
7.7.2 HEV cycle test	23
7.8 Energy efficiency test	27
7.8.1 Common tests.....	27
7.8.2 Test for cells of BEV application	29
7.8.3 Energy efficiency calculation for cells of HEV application	30
Annex A (informative) Selective test conditions.....	32
Annex B (informative) Cycle life test sequence	34
Bibliography.....	37
Figure 1 – Example of temperature measurement of cell.....	9
Figure 2 – Examples of maximum dimension of cell	11
Figure 3 – Test order of the current-voltage characteristic test	15

Figure 4 – Dynamic discharge profile A for BEV cycle test	21
Figure 5 – Dynamic discharge profile B for BEV cycle test	22
Figure 6 – Discharge-rich profile for HEV cycle test	25
Figure 7 – Charge-rich profile for HEV cycle test	26
Figure 8 – Typical SOC swing by combination of two profiles for HEV cycle test	27
Figure B.1 – Test sequence of BEV cycle test	35
Figure B.2 – Concept of BEV cycle test.....	36
Table 1 – Discharge conditions	12
Table 2 – Examples of charge and discharge current	13
Table 3 – Dynamic discharge profile A for BEV cycle test	21
Table 4 – Dynamic discharge profile B for BEV cycle test	22
Table 5 – Discharge-rich profile for HEV cycle test.....	25
Table 6 – Charge-rich profile for HEV cycle test.....	26
Table A.1 – Capacity test conditions.....	32
Table A.2 – Power test conditions	32
Table A.3 – Cycle life test conditions	32
Table A.4 – Conditions for energy efficiency test for BEV application.....	33
Table B.1 – Test sequence of HEV cycle test	36

INTRODUCTION

The commercialisation 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 hybrid electric vehicles and emerging 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 standard is to specify performance testing for automobile traction lithium-ion cells that basically differ from the other cells including those for portable and stationary applications specified by the other IEC standards. For automobile application, it is important to note the usage specificity; i.e. the designing 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 standard 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 standard is associated with ISO 12405-1-and ISO 12405-2¹.

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

¹ Under consideration.

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).

The objective of this standard is to specify 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 standard 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 1 Based on the agreement between the manufacturer and the customer, specific test conditions may be selected in addition to the conditions specified in this standard. Selective test conditions are described in Annex A.

NOTE 2 The performance tests for the electrically connected lithium-ion cells may be performed with reference to this standard.

NOTE 3 The test specification for lithium-ion battery packs and systems is defined in ISO 12405-1 and ISO 12405-2 (under consideration).

2 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 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*

3 Terms and definitions

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

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

quantity of electricity C_3 Ah (ampere-hours) for BEV and C_1 Ah for HEV declared by the manufacturer

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 ;

n is the time base (hours).

3.5 room temperature

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

3.6 secondary lithium ion cell

secondary single cell whose electrical energy is derived from the insertion/extraction reactions of lithium ions between the anode and the cathode

NOTE 1 The secondary cell is a basic manufactured unit providing a source of electrical energy by direct conversion of chemical energy. The cell 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 expressed as a percentage of rated capacity

4 Test conditions

4.1 General

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

4.2 Measuring instruments

4.2.1 Range of measuring devices

The instruments used shall enable the values of voltage and current 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 $1 \text{ M } \Omega / \text{V}$.

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 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 manufacturer shall be followed.

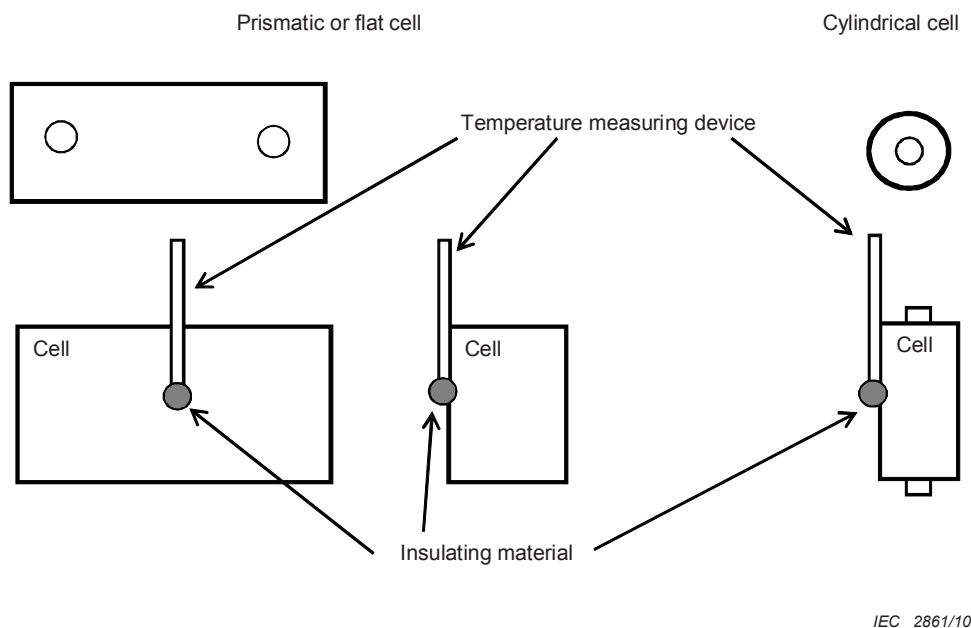


Figure 1 – Example of temperature measurement of cell

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 these 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

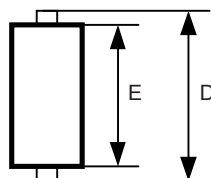
If not otherwise defined, before each test the cell shall be stabilized at the test temperature for a minimum of 12 h. This period can be reduced if thermal stabilization is reached. Thermal stabilization is considered to be reached if after one interval of 1 h, the change of cell temperature is lower than 1 K.

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

5 Dimension measurement

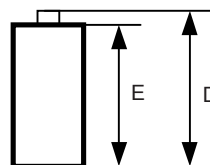
The maximum dimension of the total width, thickness or diameter, and length of a cell shall be measured up to three significant figures in accordance with the tolerances in 4.3.

The examples of maximum dimension are shown in Figures 2a to 2f.



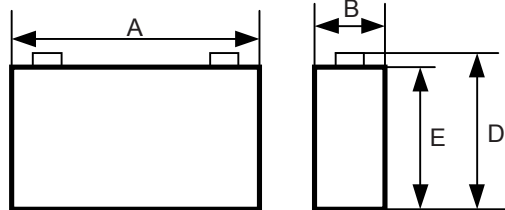
IEC 2862/10

Figure 2a – Cylindrical cell (1)



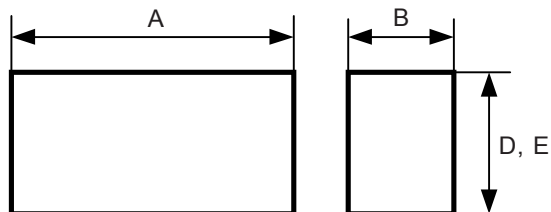
IEC 2863/10

Figure 2b – Cylindrical cell (2)



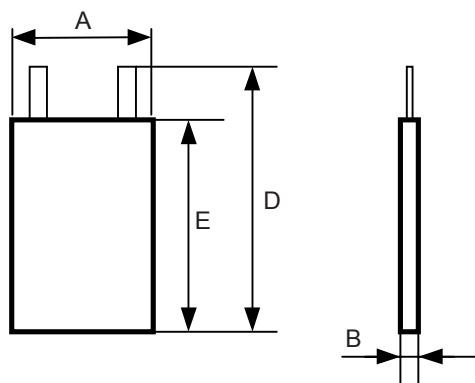
IEC 2864/10

Figure 2c – Prismatic cell (1)



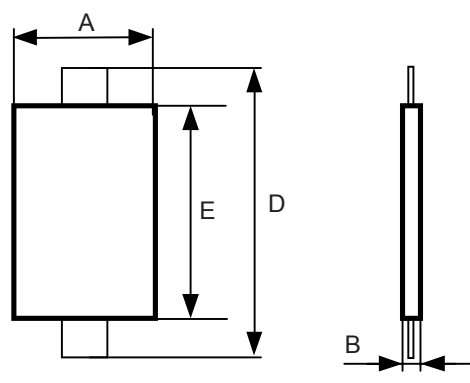
IEC 2865/10

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)

Figure 2 – Examples of maximum dimension of cell

6 Mass measurement

Mass of a cell is measured up to three significant figures in accordance with the tolerances in 4.3.

7 Electrical measurement

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

7.1 General charge conditions

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