

INTERNATIONAL STANDARD



**Secondary lithium-ion cells for the propulsion of electric road vehicles –
Part 2: Reliability and abuse testing**

<https://standards.iteh.ai>
Document Preview

[IEC 62660-2:2018](#)

<https://standards.iteh.ai/catalog/standards/iec/fb3db802-1145-44dc-9666-faaa476386e3/iec-62660-2-2018>



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2018 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

[IEC 62660-2:2018](https://standards.iteh.ai/Document/IEC/62660-2-2018)

<https://standards.iteh.ai/catalog/standards/iec/fb3db802-1145-44dc-9666-faaa476386e3/iec-62660-2-2018>



IEC 62660-2

Edition 2.0 2018-12
REDLINE VERSION

INTERNATIONAL STANDARD



**Secondary lithium-ion cells for the propulsion of electric road vehicles –
Part 2: Reliability and abuse testing**

iteh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC 62660-2:2018](#)

<https://standards.iteh.ai/catalog/standards/iec/fb3db802-1145-44dc-9666-faaa476386e3/iec-62660-2-2018>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.220.20; 43.120

ISBN 978-2-8322-6350-1

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	8
4 Test conditions	9
4.1 General.....	9
4.2 Measuring instruments.....	9
4.2.1 Range of measuring devices.....	9
4.2.2 Voltage measurement.....	9
4.2.3 Current measurement	9
4.2.4 Temperature measurements	9
4.2.5 Other measurements	10
4.3 Tolerance	10
Test temperature	10
4.4 Thermal stabilization.....	11
5 Electrical measurement	11
5.1 General charge conditions	11
5.2 Capacity	11
5.3 SOC adjustment.....	11
6 Reliability and abuse tests.....	12
6.1 General.....	12
6.2 Mechanical test.....	12
6.2.1 Vibration.....	12
6.2.2 Mechanical shock	13
6.2.3 Crush	14
6.3 Thermal test.....	15
6.3.1 High temperature endurance.....	15
6.3.2 Temperature cycling	16
6.4 Electrical test.....	19
6.4.1 External short circuit.....	19
6.4.2 Overcharge.....	20
6.4.3 Forced discharge.....	21
7 Description of test results	21
Annex A (informative) Selective test conditions.....	22
Bibliography.....	23
Figure – BEV current profile for temperature cycling.....
Figure – SOC level over all test cycles – BEV application.....
Figure – HEV current profile for temperature cycling.....
Figure 1 – Example of temperature measurement of cell.....	10
Figure 2 – PSD of acceleration vs. plotted against frequency.....	13
Figure 3 – Examples of crush test.....	15
Table – Temperatures and time duration for temperature cycling.....

Table – Test steps and BEV current profile	
Table – Test steps and HEV current profile	
Table 1 – Discharge conditions	11
Table 2 – Values for PSD and frequency.....	13
Table 3 – Mechanical shock test – parameters.....	14
Table 4 – Temperatures and time duration for temperature cycling	16
Table 5 – Test result description	21
Table A.1 – Capacity test conditions	22

iTeh Standards
(<https://standards.itih.ai>)
Document Preview

[IEC 62660-2:2018](#)

<https://standards.itih.ai/catalog/standards/iec/fb3db802-1145-44dc-9666-faaa476386e3/iec-62660-2-2018>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SECONDARY LITHIUM-ION CELLS FOR
THE PROPULSION OF ELECTRIC ROAD VEHICLES –****Part 2: Reliability and abuse testing**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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 62660-2 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 procedure of forced discharge test has been clarified (6.4.3.2).
- b) "Cell block" has been added to the scope (Clause 1).
- c) Option of temperature cycling test with electrical operation has been deleted (6.3.2).
- d) The test conditions for overcharge test have been revised (6.4.2.2).

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

FDIS	Report on voting
21/976/FDIS	21/986/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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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 reliability and abuse requirements of lithium-ion batteries is indispensable for securing a basic level of safety and obtaining essential data for the design of vehicle systems and battery packs.

This document specifies reliability and abuse 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. ~~For the requirements for cells differ depending on the system designs of battery pack or vehicle, and should be evaluated by the users,~~ This document does not provide any pass-fail criteria for the tests, but specifies a standard classification of descriptions for test results.

This document is associated with ~~ISO 12405-1 and ISO 12405-2~~ ISO 12405-4 [1]¹.

IEC 62660-1 [2] specifies the performance testing of lithium-ion cells for electric vehicle application.

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

IEC 62660-2:2018

<https://standards.iteh.ai/catalog/standards/iec/fb3db802-1145-44dc-9666-faaa476386e3/iec-62660-2-2018>

¹ Numbers in square brackets refer to the Bibliography.

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

Part 2: Reliability and abuse testing

1 Scope

This part of IEC 62660 specifies test procedures to observe the reliability and abuse behaviour of secondary lithium-ion cells and cell blocks used for propulsion of electric vehicles including battery electric vehicles (BEV) and hybrid electric vehicles (HEV).

NOTE 1 Secondary lithium-ion cells used for propulsion of plug-in hybrid electric vehicles (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 standard test procedures and conditions for basic characteristics of lithium-ion cells for use in propulsion of battery and hybrid electric vehicles. The tests are indispensable for obtaining essential data on reliability and abuse behaviour of lithium-ion cells for use in various designs of battery systems and battery packs.

This document provides standard classification of description of test results to be used for the design of battery systems or battery packs.

~~NOTE The reliability and abuse tests for the electrically connected lithium-ion cells may be performed with reference to this standard.~~

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

NOTE 2 Cell blocks can be used as an alternative to cells according to the agreement between the cell manufacturer and the customer.

NOTE 3 The safety requirements of lithium-ion cells for electric vehicle application are defined in IEC 62660-3 [3].

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 60068-2-64, *Environmental testing – Part 2-64: Tests – Test Fh: Vibration, broadband random and guidance*

~~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 16750-3, *Road vehicles – Environmental conditions and testing for electrical and electronic equipment – Part 3: Mechanical loads*

ISO 16750-4, *Road vehicles – Environmental conditions and testing for electrical and electronic equipment – Part 4: Climatic loads*

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

cell block

group of cells connected together in parallel configuration with or without protective devices, e.g. fuse or positive temperature coefficient resistor (PTC), not yet fitted with its final housing, terminal arrangement and electronic control device

3.3

hybrid electric vehicle

HEV

vehicle with both a rechargeable energy storage system and a fuelled power source for propulsion

3.4

rated capacity

~~quantity of electricity C_n 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.

3.5

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);~~

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.

3.6 room temperature

temperature of 25 °C ± 2 K

3.7 secondary lithium-ion 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. 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 cells means the secondary lithium-ion cell to be used for the propulsion of electric road vehicles.~~

3.8 state of charge SOC

available capacity in a battery cell 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.

NOTE Test and measurement can be conducted under fixing conditions 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 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 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 should be measured at a location which most closely reflects the cell or cell block 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.

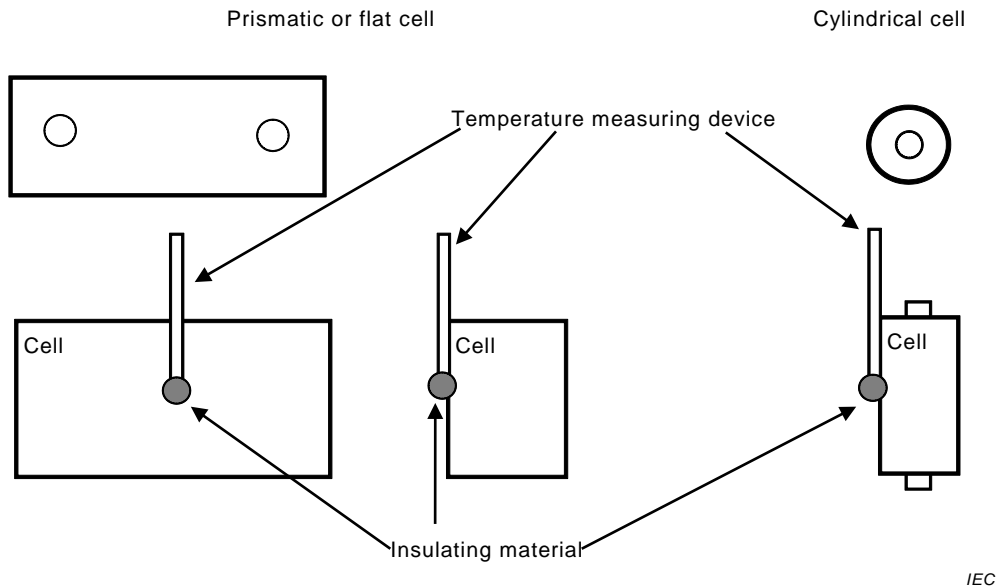


Figure 1 – Example of temperature measurement of cell

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 Electrical measurement

5.1 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 according to the charging method declared by the cell manufacturer at room temperature.

5.2 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 5.1.

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 temperatures indicated in Table 1 shall be used.

NOTE 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 provided in Annex A.

~~The method of designation of test current I_t is defined in IEC 61434.~~

Table 1 – Discharge conditions

Cell temperature °C	Discharge current A	
	BEV application	HEV application
0	$1/3 I_t$	$1 I_t$
25		
45		

Phase 3 – Measure the discharge ~~endurance~~ 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).

5.3 SOC adjustment

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

Phase 1 – The cell shall be charged in accordance with 5.1.

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.

6 Reliability and abuse tests

6.1 General

For all the tests specified in Clause 6, the test installation shall be reported including fixing and wiring of the cell. If necessary, to prevent deformation, the cell may be maintained during the test in a manner that does not violate the test purpose.

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

The value of SOC may be changed according to the agreement between the customer and the cell manufacturer.

6.2 Mechanical test

6.2.1 Vibration

6.2.1.1 Purpose

This test is performed to characterize cell responses to vibration assumed in the use of a vehicle.

6.2.1.2 Test

The test shall be performed as follows.

- a) Adjust the SOC of the cell to 100 % for BEV application, and to 80 % for HEV application in accordance with 5.3.
- b) Perform the test referring to IEC 60068-2-64 random vibration. Use test duration of 8 h for each plane of the test cell.
- c) The RMS acceleration value shall be 27,8 m/s². The power spectrum density (PSD) ~~vs~~ plotted against frequency is shown in Figure 2 and Table 2. The maximum frequency shall be 2 000 Hz.