IEC 62485-6

Edition 1.0 2021-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Safety requirements for secondary batteries and battery installations – Part 6: Safe operation of lithium ion batteries in traction applications

Exigences de sécurité pour les batteries d'accumulateurs et les installations de batteries – Partie 6: Fonctionnement en toute sécurité des batteries ions-lithium dans les applications de traction



IEC 62485-6:2021-01(en-fr)



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2021 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.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembé
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 corrigendum or an amendment might have been published.

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 It also gives information on projects, replaced and withdrawn publications.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 once a month by email.

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 online collection - oc.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC
La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, …). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC online collection - oc.iec.ch
Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

IEC 62485-6

Edition 1.0 2021-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Safety requirements for secondary batteries and battery installations – Part 6: Safe operation of lithium ion batteries in traction applications

Exigences de sécurité pour les batteries d'accumulateurs et les installations de batteries – Partie 6: Fonctionnement en toute sécurité des batteries ions-lithium dans les applications de traction

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 29.220.20; 29.220.30

ISBN 978-2-8322-9126-9

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

® Registered trademark of the International Electrotechnical Commission
Marque déposée de la Commission Electrotechnique Internationale

CONTENTS

FOREWORD 4
1 Scope 6
2 Normative references 6
3 Terms and definitions 8
4 Protection against electric shock by the battery and charger 10
4.1 General 10
4.2 Basic protection and fault protection 10
4.3 Basic protection and fault protection when discharging the traction battery on the vehicle (battery disconnected from charger/mains) 11
4.3.1 Batteries up to and including 60 V DC 11
4.3.2 Batteries exceeding 60 V DC up to and including 120 V DC 11
4.3.3 Batteries exceeding 120 V DC but not exceeding 1 500 V DC 11
4.4 Basic protection and fault protection when charging the traction battery 11
5 Prevention of short-circuits and protection from other effects of electric current 12
5.1 Cables and connectors 12
5.2 Protective measures during maintenance 12
5.3 Battery insulation 13
5.3.1 Insulation resistance 13
5.3.2 Insulation resistance measurement 13
6 Provisions against hazards 13
6.1 General 13
6.2 Charging modes 13
6.3 Temperature influence on the charge voltage and limiting of charge current 14
6.4 Overcharging or overdischarging under fault conditions 14
6.5 Prevention of electrostatic discharges when working with batteries 14
7 Provision against hazards by chemical substances 14
7.1 General 14
7.2 Initial actions in case of hazardous chemical release 14
7.3 Eye or skin contact 14
7.4 Swallowing 14
7.5 Respiratory tract 15
7.6 Burns 15
8 Battery containers and enclosures 15
9 Battery change 15
10 Battery peripheral equipment/accessories 15
10.1 Battery management system 15
10.2 Thermal management systems and series installation 16
10.3 Connectors (plugs/sockets) 16
11 Charge current requirements 16
11.1 Peak voltage/current by charging 16
11.2 Superimposed ripple current 17
11.3 Maximum ripple current 17
12 Identification labels, warning notices and instructions for use, installation and maintenance 17
12.1 General 17
12.2 Warning labels 17

12.3 Identification label 18
12.4 Instructions 18
12.5 Other labels 18
13 Transportation, storage, disposal and environmental aspects 18
13.1 Packing and transport 18
13.2 Disassembly, disposal, and recycling of batteries 19
13.3 Storage 19
14 Inspection and monitoring 19
15 EMC for traction application 19
Annex A (informative) Cell behaviour inside and outside of operating region 20
Annex B (normative) Electromagnetic compatibility (EMC) 21
B.1 Case 1 – EMC requirements of battery systems depending of each end-device application 21
B.2 Case 2 – EMC requirements for testing battery system as an end-device 21
Bibliography 22

Figure A.1 – An example for operating region of lithium ion cell 20

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

SAFETY REQUIREMENTS FOR SECONDARY BATTERIES AND BATTERY INSTALLATIONS –

Part 6: Safe operation of lithium ion batteries in traction applications

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.

International Standard IEC 62485-6 has been prepared by IEC technical committee 21: Secondary cells and batteries.

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

FDIS	Report on voting
21/1071/FDIS	21/1077/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 62485 series, published under the general title *Safety requirements for secondary batteries and battery installations*, 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.

The contents of the corrigendum 1 (2023-02) have been included in this copy.

SAFETY REQUIREMENTS FOR SECONDARY BATTERIES AND BATTERY INSTALLATIONS –

Part 6: Safe operation of lithium ion batteries in traction applications

1 Scope

This part of IEC 62485 applies to battery installations used for electric off-road vehicles; it does not cover the design of such vehicles.

Examples of the main applications are:

– industrial
  - cleaning machines,
  - trucks for material handling, for example, lift trucks, tow trucks, automatic guided vehicles,
  - electrically propelled lifting platforms;
– other applications
  - electric powered boats and ships.

This document covers the safety aspects of battery installations in such applications. This document does not cover railway vehicles, for traction railway application, see IEC 62928.

This document does not cover batteries and battery installations for the propulsion of electric road vehicles. In the event of there being a variation of requirements between this document and those of a relevant product standard (e.g. goods vehicles, bicycles, wheel chairs, golf carts), then the product standard requirements take precedence.

Lithium ion cells and batteries used in traction industrial application are intended to fulfil safety requirements in accordance with IEC 62619.

The maximum voltages are limited to 1 000 V AC and to 1 500 V DC, and the principal measures for protection against hazards, generally from electricity, gas emission and electrolyte to prevent fire and explosion are described.

This document provides requirements on safety aspects associated with the installation, use, inspection, maintenance and disposal of lithium ion batteries. Batteries containing lithium metal are not covered by this document.

In general, the safety requirements for secondary batteries and battery installations – General safety information and definitions are specified for lead-acid, nickel-cadmium and nickel-metal hybrid batteries in accordance with IEC 62485-1.

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 60204-1, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*
IEC 60364-4-41:2005/AMD1:2017

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 61000-1-2, *Electromagnetic compatibility (EMC) – Part 1-2: General – Methodology for the achievement of functional safety of electrical and electronic systems including equipment with regard to electromagnetic phenomena*

IEC 61000-6-1, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity standard for residential, commercial and light-industrial environments*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments*

IEC 61000-6-3, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments*

IEC 61000-6-4, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*

IEC 61000-6-7, *Electromagnetic compatibility (EMC) – Part 6-7: Generic standards – Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 62619:2017, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications*

IEC 62620:2014, *Secondary cells and batteries containing alkaline or other non-acid electrolytes –Secondary lithium cells and batteries for use in industrial applications*

ISO 3864 (all parts), *Graphical symbols – Safety colours and safety signs*

EN 1175-1:2011, *Safety of industrial trucks – Electrical requirements – Part 1: General requirements for battery powered trucks*

UN Regulation No. 100 (UN R 100):2011, *Uniform provisions concerning the approval of vehicles with regard to specific requirements for the electric power train*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
secondary lithium cell
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.

Note 2 to entry: A cell is not ready for use in an application because it is not yet fitted with its final housing, terminal arrangement and electronic control device.

3.2
lithium ion battery
secondary battery with an organic solvent electrolyte and positive and negative electrodes which utilize an intercalation compound in which lithium is stored

Note 1 to entry: A lithium ion battery does not contain lithium metal.

[SOURCE: IEC 60500-482:2004, 482-05-07]

3.3
electrolyte
liquid or solid substance containing mobile ions which render it ionically conductive

Note 1 to entry: The electrolyte may be liquid, solid or a gel.

[SOURCE: IEC 60500-482:2004, 482-02-29]

3.4
battery management system
BMS
electronic system associated with a battery which has functions to control current in case of overcharge, overcurrent, overdischarge, and overheating, and which monitors and/or manages the state of the battery, calculates secondary data, reports that data and/or controls its environment to influence the battery's safety, performance and/or service life

Note 1 to entry: Overdischarge cut off is not mandatory if there is an agreement on this between the cell manufacturer and the customer.

Note 2 to entry: The function of the battery management system (BMS) can be assigned to the battery pack or to equipment that uses the battery.

Note 3 to entry: The BMS can be divided and it can be found partially in the battery pack and partially on the equipment that uses the battery.

Note 4 to entry: The BMS is sometimes also referred to as a BMU (battery management unit).

3.5
nominal voltage
suitable approximate value of the voltage used to designate or identify a cell or a battery

Note 1 to entry: The cell or battery manufacturer may provide the nominal voltage.

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 – Omission of "electrochemical system" from the definition, and addition of Notes 1 and 2.]

3.6
overcharge
<of a cell or battery> continued charging after the full charge of a secondary cell or battery

Note 1 to entry: Overcharge is also the act of charging beyond a certain limit specified by the manufacturer.

[SOURCE: IEC 60500-482:2004, 482-05-44, modified – The domain has been added and the wording "of a fully charged" has been replaced with "after the full charge of" in the definition.]

3.7
overdischarge
state of the battery when one or more cells of the battery are discharged below their lower limit discharge voltage

3.8
traction battery
secondary battery which is designed to provide the propulsion energy for electric vehicles

3.9
lower limit discharging voltage
lowest discharging voltage in the cell operating region specified by the cell manufacturer

3.10
external short-circuit
abnormally high current discharge due to a conductive fault over parts at opposite polarity either within the battery circuitry or over the external terminals

3.11
internal short-circuit
electrical conduction through insulation within the cell due to cell manufacturing defects, cell design faults or damage due to abuse of the cell during its use

3.12
module
group of cells connected together either in a series and/or parallel configuration with or without protective devices (e.g. fuse or positive temperature coefficient device (PTC)) and monitoring circuitry

3.13
battery system
battery
system which comprises one or more cells, modules or battery packs and has a battery management system capable of controlling current in case of overcharge, overcurrent, overdischarge and overheating

Note 1 to entry: Overdischarge cut off is not mandatory if there is an agreement on this between the cell manufacturer and the customer.

Note 2 to entry: The battery system may have cooling or heating units. A larger battery system may comprise more than one battery system. The battery system is sometimes also referred to as a battery.

3.14
cell block
group of cells connected together in parallel configuration with or without protective devices (e.g. fuse or positive temperature coefficient device (PTC)) and monitoring circuitry

Note 1 to entry: 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.

3.15
battery pack
energy storage device comprised of one or more cells or modules electrically connected, and has monitoring circuitry which provides information (e.g. cell voltage) to a battery system to influence the battery's safety, performance and/or service life

Note 1 to entry: It may incorporate a protective housing and be provided with terminals or other interconnection arrangements.

4 Protection against electric shock by the battery and charger

4.1 General

Measures should be taken for protection against direct contact (basic protection) and against indirect contact (fault protection) with hazardous voltages while the traction batteries are installed in the vehicle and during battery charging procedures.

These measures are described in detail in IEC 60364-4-41 and IEC 61140. The following subclauses describe the typical measures to be taken for traction battery installations and the resulting adaptions.

The appropriate equipment standard IEC 61140 applies to batteries and direct current distribution circuits located inside the equipment.

4.2 Basic protection and fault protection

For batteries when installed in the vehicle and in battery charging installations if removed from the vehicle for charging, protection against direct contact with live parts shall be ensured in accordance with IEC 60364-4-41.

The following protective measures against direct contact apply:

– protection by insulation of live parts;
– protection by barriers or enclosures;
– protection by obstacles;
– protection by placing out of reach.

The following protective measures against indirect contact apply:

– protection by automatic disconnection or signalling;
– protection by protective insulation;
– protection by earth-free local equipotential bonding;
– protection by electrical separation.