IEC 62973-5

Edition 1.0 2023-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Railway applications – Rolling stock – Batteries for auxiliary power supply systems –
Part 5: Lithium-ion batteries

Applications ferroviaires – Matériel roulant – Batteries pour systèmes d'alimentation auxiliaire –
Partie 5: Batteries lithium-ion

IEC 62973-5:2023-08(en-fr)

IEC Secretariat
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 It also gives information on projects, replaced and withdrawn publications.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 Products & Services Portal - products.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 22 300 terminological entries in English and French, with equivalent terms in 19 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 Products & Services Portal - products.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 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

IEC 62973-5

Edition 1.0 2023-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Railway applications – Rolling stock – Batteries for auxiliary power supply systems – Part 5: Lithium-ion batteries

Applications ferroviaires – Matériel roulant – Batteries pour systèmes d'alimentation auxiliaire – Partie 5: Batteries lithium-ion

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 29.220.20

ISBN 978-2-8322-7369-2

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

RAILWAY APPLICATIONS – ROLLING STOCK – BATTERIES FOR AUXILIARY POWER SUPPLY SYSTEMS –

Part 5: Lithium-ion batteries

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.

IEC 62973-5 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways. It is an International Standard.

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

Draft	Report on voting
9/2974/FDIS	9/2995/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 62973 series, published under the general title *Railway applications – Rolling stock – Batteries for auxiliary power supply systems*, 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 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 document 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.

RAILWAY APPLICATIONS – ROLLING STOCK – BATTERIES FOR AUXILIARY POWER SUPPLY SYSTEMS –

Part 5: Lithium-ion batteries

1 Scope

This part of IEC 62973 applies to lithium-ion batteries for auxiliary power supply systems used on rolling stock. This document specifies the requirements of the characteristics and tests for the lithium-ion cells, and supplements IEC 62973-1 which is applied to any rolling stock types (e.g. light rail vehicles, tramways, streetcars, metros, commuter trains, regional trains, high speed trains, locomotives, etc.).

Unless otherwise specified in this document, the requirements of IEC 62973-1 apply.

This document specifies the requirements of the interface between battery system including BMS and the converter.

This document is used in conjunction with generic IEC 62619 (safety requirements) and IEC 62620 (performance requirements) of lithium-ion cells and batteries used in industrial applications. This document specifies the requirements for railway rolling stock applications.

Such batteries for auxiliary power supply systems are also sometimes used for:

– occasional traction power for shunting in depot, or for rescue or emergency mode such as stop on third rail gaps;
– peak power shaving and engine starting.

If the nominal battery voltage exceeds the voltage specified in Table 1 of IEC 62973-1:2018, then IEC 62928 applies to the battery.

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 60077-1:2017, *Railway applications – Electric equipment for rolling stock – Part 1: General service conditions and general rules*

IEC 62498-1:2010, *Railway applications – Environmental conditions for equipment – Part 1: Equipment on board rolling stock*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*
IEC 60529:1989/AMD1:1991
IEC 60529:1989/AMD2:2013

IEC 62619:2022, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements secondary lithium cells and batteries for use in industrial applications*

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

IEC 62928:2017, *Railway applications – Rolling stock – Onboard lithium-ion traction batteries*

IEC 62973-1:2018, *Railway applications Rolling stock – Batteries for auxiliary power supply systems – Part 1: General requirements*

ISO 7010, *Graphical symbols – Safety colours and safety signs – Registered safety signs*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62973-1:2018, and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

NOTE 1 In case there is the same term and definition in IEC 62973-1:2018, then the definition given in this document applies.

NOTE 2 All typical battery related descriptions are defined in IEC 60050-482.

3.1.1
cell
secondary lithium 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. 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.

[SOURCE: IEC 62620:2014, 3.6]

3.1.2
cell block
group of cells connected together in parallel configuration with or without protective devices (e.g. fuse or PTC device) 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.

[SOURCE: IEC 62620:2014, 3.7, modified – The word "device" has been added after "PTC" in the definition.]

3.1.3
battery pack
module
group of cells connected together either in series and/or parallel configuration with or without protective devices (e.g. fuse or PTC device) and monitoring circuitry

Note 1 to entry: It incorporates a protective housing and be provided with terminals or other interconnection arrangement.

Note 2 to entry: It includes at least monitoring circuitry, which provides information (e.g. cell voltage, temperature) to a battery system.

Note 3 to entry: It may include a protective device and control circuitry.

[SOURCE: IEC 62973-1:2018, 3.1.9, modified – The term "battery module" has been replaced with "battery pack" and "module", in the definition, "temperature sensor" has been replaced with "PTC" and notes to entry added.]

3.1.4
rated capacity
<of the battery> capacity value determined under specified conditions and declared by the manufacturer

Note 1 to entry: The rated capacity is the quantity of electricity Cn Ah (ampere-hours) declared by the manufacturer which a single cell or battery can deliver during a n h period when charging, storing and discharging under the conditions specified in IEC 62620:2014, 6.3.1. n is 5 for an E, M and H discharge rate type cell or battery. n is 8, 10, 20 or 240 for an S discharge rate type battery.

[SOURCE: IEC 62620:2014, 3.5, modified – domain <of the battery> added, "of a cell or battery" deleted from the definition, and in Note 1 to entry, IEC 62620:2014 has been added.]

3.1.5
battery system
<for a lithium-ion battery> system which incorporates one or more cells, modules or battery packs including battery management system and thermal management system as well as disconnecting and/or isolating devices, e.g. contactors, disconnectors, fuses, etc.

Note 1 to entry: Refer to Figure 2, Figure 3 and Figure A.1 to Figure A.4 in IEC 62928:2017.

[SOURCE: IEC 62928:2017, 3.1.11, modified – domain <for a lithium-ion battery> added.]

3.1.6
battery management system
BMS
system associated with a battery pack which monitors and/or manages its state, disconnects or isolates the battery pack, calculates secondary data, communicates data outside of the battery system and/or controls its environment to influence the battery's safety, performance and/or service life

Note 1 to entry: The function of the BMS can be assigned to the battery pack or to equipment that uses the battery pack.

Note 2 to entry: Its function includes thermal control.

[SOURCE: IEC 62620:2014, 3.11, modified – "electronic" has been deleted, "disconnects or isolates the battery pack," has been added, "reports that data" has been replaced with "communicates data outside of the battery system" and "and has the functions to cut …" has been deleted. Note 2 to entry has been replaced.]

3.1.7
battery thermal management system
BTMS
system associated with a battery pack which monitors and/or manages its thermal behaviour in order to maintain the temperature of the battery pack in the intended range for load profile agreed between the integrator and the battery system manufacturers

Note 1 to entry: BTMS is optional to control environmental conditions inside the battery system, e.g. air conditioning (temperature, humidity, etc.).

[SOURCE: IEC 62928:2017, 3.1.30, modified – Note to entry added.]

3.1.8
emergency mode
operating situation of rolling stock when primary power is not available

3.1.9
exceptional use case
situation exceeding the worst case of an agreed load profile

3.1.10
end user
organization which operates the lithium-ion battery system

Note 1 to entry: The end user is normally an organization which operates the vehicle equipped with the battery system, unless the responsibility is delegated to a main contractor or consultant.

[SOURCE: IEC 62973-1:2018, 3.1.11, modified – "lithium-ion" inserted.]

3.1.11
system integrator
organization which has the technical responsibility of the complete lithium-ion battery system including BMS and charging system

Note 1 to entry: The system integrator can be the end user or the train manufacturer, or neither of them.

[SOURCE: IEC 62973-1:2018, 3.1.12, modified, – "lithium-ion" and "including BMS" inserted.]

3.1.12
manufacturer
organization which has the technical responsibility for its scope of supply

Note 1 to entry: The manufacturer can be the train builder or the system integrator of a battery system, a cell manufacturer, etc. If necessary to explicitly distinguish, "train manufacturer", "battery system manufacturer" or "cell manufacturer" is specified.

[SOURCE: IEC 62973-1:2018, 3.1.13, modified, – In the Note to entry, "is expressed" has been replaced with "is specified".]

3.2 Abbreviated terms

AC Alternating Current
APU Auxiliary Power Unit
DC Direct Current
DOD Depth of Discharge
FEA Finite Element Analysis
LRU Line Replaceable Unit
LVPS Low Voltage Power System

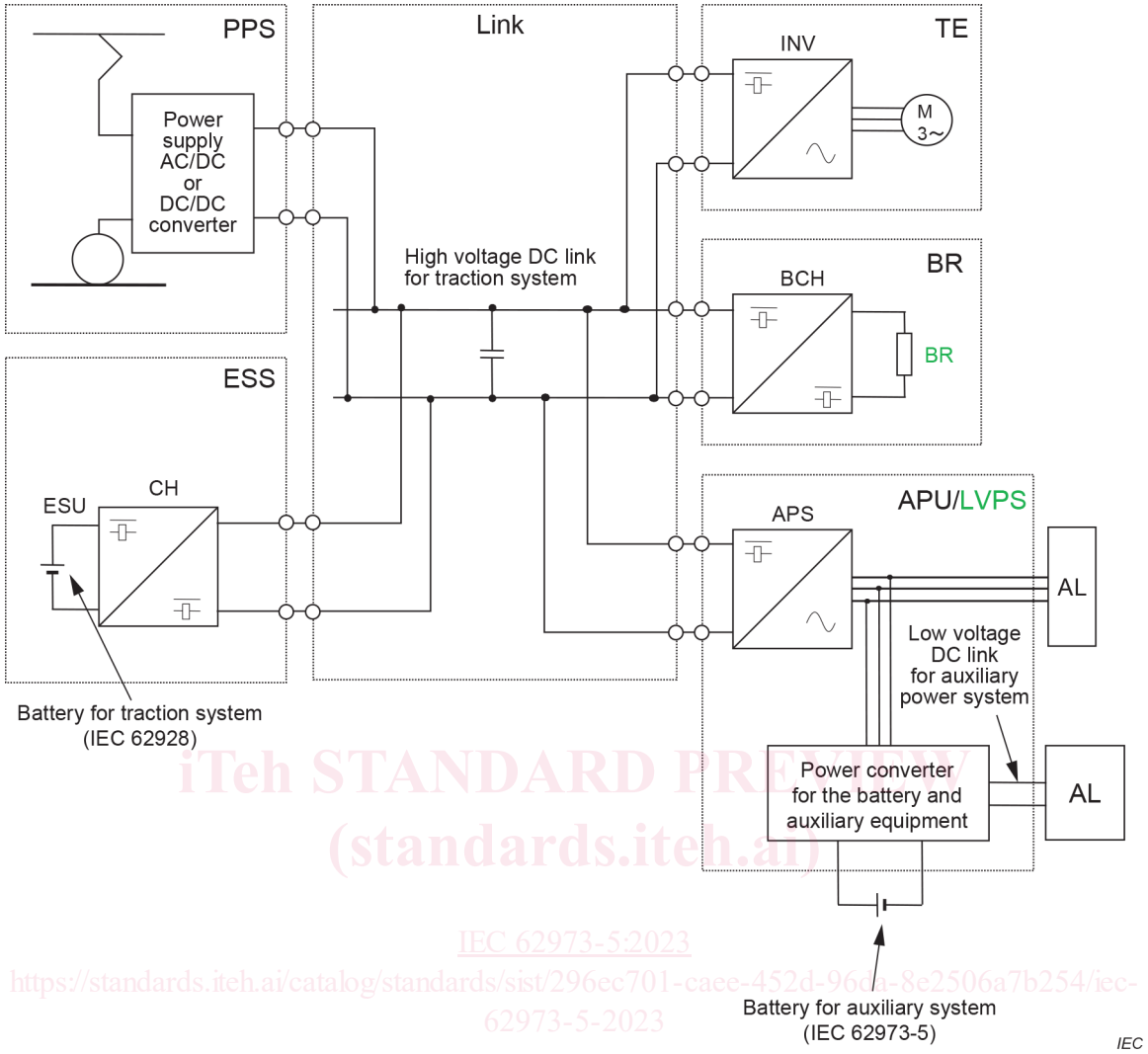
PTC Positive Temperature Coefficient

SOC State of Charge

4 General requirements

4.1 Architecture of an auxiliary battery system in the train

Typical architecture of an auxiliary battery system including its integration into the train system is shown in Figure 1.



Key

AL	Auxiliary load
APS	Auxiliary power supply
APU	Auxiliary power unit
AUX	Auxiliary system
BCH	Brake chopper
BR	Brake resistor
CH	Chopper converter
ESS	Energy storage system
ESU	Energy storage unit
INV	Inverter
LVPS	Low voltage power system
PPS	Primary power source
TE	Traction equipment

Figure 1 – Typical integration of an auxiliary battery system in the energy distribution architecture

4.2 Definitions of components of a battery system

Figure 2 shows typical hierarchy of the auxiliary battery system. Images are examples of the level of integration of cells, battery packs/modules, trays and battery boxes.

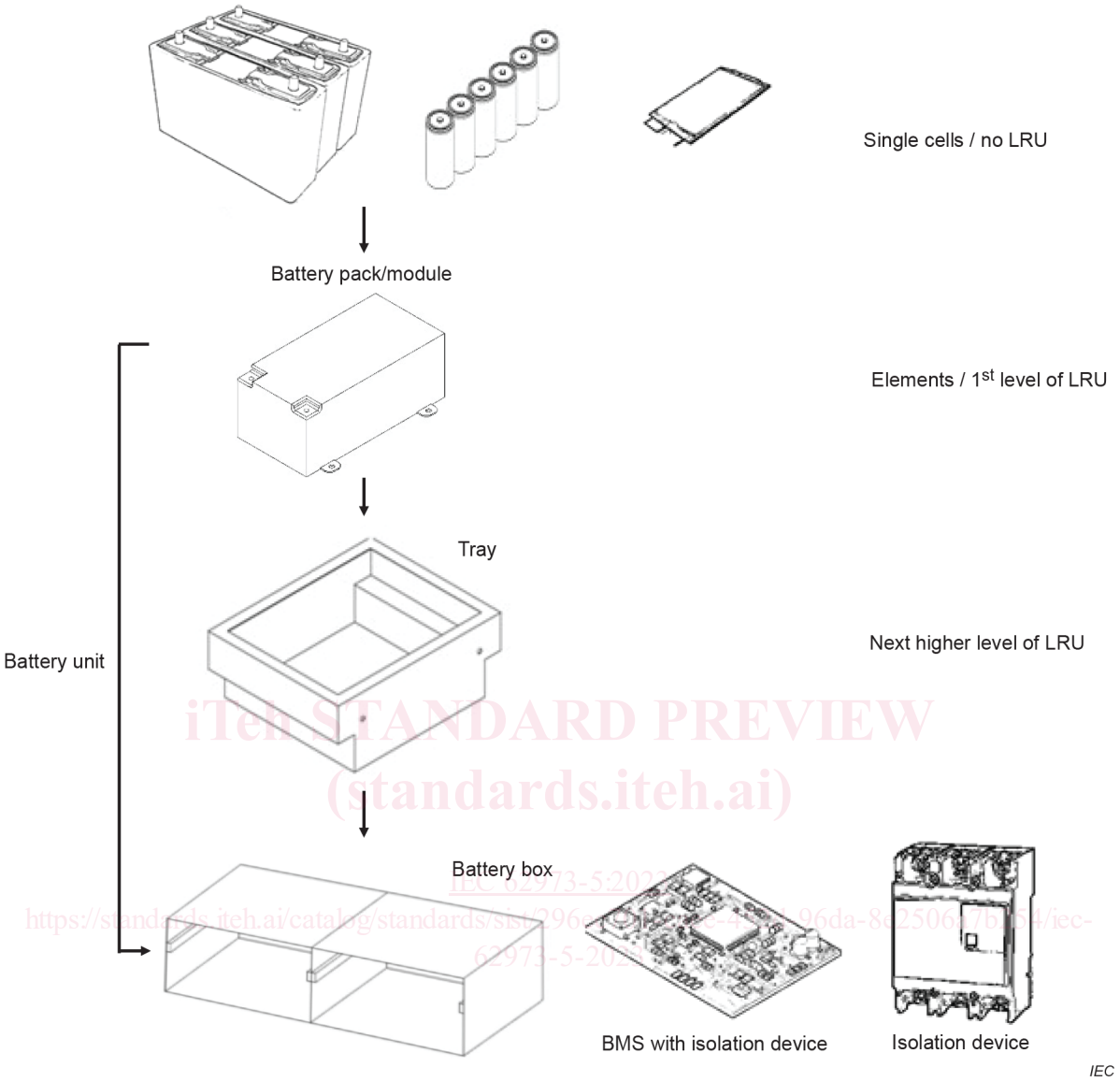


Figure 2 – Typical hierarchy of the auxiliary battery system

Some batteries can include some of the above components, e.g. battery packs/modules may be installed in a battery box without a tray.

4.3 Definitions of battery type

4.3.1 General

A battery system consists of a number of cells, cell blocks or battery pack/modules that are assembled in trays and then assembled in a battery box. Each cell contains electrolyte and stacked, wound or folded positive electrode(s), negative electrode(s) and separators. The electrodes are connected to positive and negative terminals that are accessible on the outside of the cell container.

Secondary lithium cells may contain multiple types of lithium compounds which result in different properties, performances and operational parameters. Different types of cells shall not be mixed together in same battery without formal approval from the battery system manufacturer and cell manufacturer.