INTERNATIONAL STANDARD

ISO 12405-4

First edition
2018-07

Electrically propelled road vehicles — Test specification for lithium-ion traction battery packs and systems —

Part 4: Performance testing

Véhicules routiers à propulsion électrique — Spécifications d'essai pour packs et systèmes de batterie de traction aux ions lithium —

Partie 4: Essais de performance

Reference number
ISO 12405-4:2018(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 37, *Electrically propelled vehicles*.

This document cancels and replaces ISO 12405-1:2011 and ISO 12405-2:2012 by summarizing the test specifications.

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Introduction

Lithium-ion-based battery systems are an efficient alternative energy storage system for electrically propelled vehicles. The requirements for lithium-ion based battery systems for use as a power source for the propulsion of electric road vehicles are significantly different from those batteries used for consumer electronics or stationary usage.

This document provides specific test procedures for lithium-ion battery packs and systems specially developed for propulsion of road vehicles. This document specifies such tests and related requirements to ensure that a battery pack or system is able to meet the specific needs of the automobile industry. It enables vehicle manufactures to choose test procedures to evaluate the characteristics of a battery pack or system for their specific requirements.

ISO 12405 specifies test procedures for lithium-ion battery packs and systems which are connected to the electric propulsion system of electrically propelled vehicles.

The objective of ISO 12405 is to specify standard test procedures for the basic characteristics of performance, reliability and electrical functionality of lithium-ion battery packs and systems and to assist the user in comparing the test results achieved for different battery packs or systems.

NOTE 1 The general safety relevant tests and requirements are given in ISO 6469-1[1)].

NOTE 2 Environmental conditions and testing will be given in the future ISO 19453-6[2)].

For specifications for battery cells, see IEC 62660-1 to 3.

1) Under preparation. Stage at the time of publication: ISO/DIS 6469-1.

2) Under preparation. Stage at the time of publication: ISO/CD 19453-6.

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Electrically propelled road vehicles — Test specification for lithium-ion traction battery packs and systems —

Part 4: Performance testing

1 Scope

This document specifies test procedures for the basic characteristics of performance, reliability and electrical functionality for the battery packs and systems for either high-power or high-energy application. Unless otherwise stated, the test applies to both applications.

NOTE 1 Typical applications for high-power battery packs and systems are hybrid electric vehicles (HEVs) and some type of fuel cell vehicles (FCVs).

NOTE 2 Typical applications for high-energy battery packs and systems are battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs) and some type of fuel cell vehicles (FCVs).

NOTE 3 Testing on cell level is specified in IEC 62660 series.

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.

ISO 6469-1[3], *Electrically propelled road vehicles — Safety specifications — Part 1: On-board rechargeable energy storage system (RESS)*

ISO 6469-3[4], *Electrically propelled road vehicles — Safety specifications — Part 3: Protection of persons against electric shock*

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 https://www.iso.org/obp

3.1
battery control unit
BCU
electronic device that controls, manages, detects or calculates electric and thermal functions of the *battery system* (3.3) and that provides communication between the battery system and other vehicle controllers

Note 1 to entry: See A.3.1 for further explanations.

3) Under preparation. Stage at the time of publication: ISO/DIS 6469-1.

4) Under preparation. Stage at the time of publication: ISO/DIS 6469-3.

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3.2
battery pack
energy storage device that includes cells or cell assemblies normally connected with *cell electronics* (3.5), power supply circuits and overcurrent shut-off device, including electrical interconnections, interfaces for external systems

Note 1 to entry: See A.2 for further explanations.

Note 2 to entry: Examples of external systems are cooling, voltage class B, auxiliary voltage class A and communication.

3.3
battery system
energy storage device that includes cells or cell assemblies or *battery pack*(s) (3.2) as well as electrical circuits and electronics

Note 1 to entry: See A.3.2 and A.3.3 for further explanations. Battery system components can also be distributed in different devices within the vehicle.

Note 2 to entry: Examples of electronics are the BCU and contactors.

3.4
capacity
total number of ampere hours that can be withdrawn from a fully charged *battery pack* (3.2) under specified conditions

3.5
cell electronics
electronic device that collects and possibly monitors thermal or electric data of cells or cell assemblies and contains electronics for cell balancing, if necessary

Note 1 to entry: The cell electronics can include a cell controller. The functionality of cell balancing can be controlled by the cell electronics or by the BCU.

3.6
customer
party that is interested in using the battery pack or system and therefore orders or performs the test

EXAMPLE A vehicle manufacturer.

3.7
device under test
DUT
battery pack or battery system

3.8
electric drive
combination of a traction motor, power electronics and their associated controls for the conversion of electric to mechanical power and vice versa

3.9
electrically propelled vehicle
vehicle with one or more *electric drive*(s) (3.8) for vehicle propulsion

3.10
energy density
amount of stored energy related to the *battery pack* (3.2) or *system* (3.3) volume

Note 1 to entry: The battery pack or system includes the cooling system, if any, to the point of a reversible attachment of the coolant lines or air ducts, respectively.

Note 2 to entry: Energy density is expressed in watt hours per litre (Wh/l).

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3.11
energy round trip efficiency
ratio of the net d.c. energy delivered by a DUT during a discharge test to the total d.c. energy required to restore the initial SOC by a standard charge

Note 1 to entry: The net d.c. energy is expressed as watt hours (Wh) discharge and the total d.c. energy is expressed as watt hours (Wh) charge.

3.12
high-energy battery pack and system
battery pack (3.2) and *system* (3.3) using cells, which have the numerical ratio between maximum allowed electric power output and electric energy output at a 1C discharge rate at RT lower than 10

Note 1 to entry: Typically high-energy battery packs and systems are designed for applications in BEVs and PHEVs.

Note 2 to entry: The allowed electric power output is expressed as power in watts (W) and the electric energy output is expressed as energy in watt hours (Wh).

3.13
high-power battery pack and system
battery pack (3.2) and *system* (3.3) using cells, for which the numerical ratio between maximum allowed electric power output and electric energy output at a 1C discharge rate at RT equal to or higher than 10

Note 1 to entry: Typically high-power battery packs and systems are designed for applications in HEVs and FCVs.

Note 2 to entry: The allowed electric power output is expressed as power in watts (W) and the electric energy output is expressed as energy in watt hours (Wh).

3.14
maximum working voltage
highest value of a.c. voltage (rms) or of d.c. voltage which may occur in an electric system under any normal operating conditions according to the supplier's specifications, disregarding transients

3.15
overcurrent protection
protection intended to operate when the current is in excess of a predetermined value

3.16
rated capacity
supplier's specification of the total number of ampere hours that can be withdrawn from a fully charged battery pack or system for a specified set of test conditions such as discharge rate, temperature and discharge cut-off voltage

3.17
room temperature
RT
temperature of (25 ± 2) °C

3.18
sign of battery current
discharge current is specified as positive and the charge current as negative

3.19
specific energy
amount of stored energy related to the *battery pack* (3.2) or *system* (3.3) mass

Note 1 to entry: The mass of battery pack or system includes the mass of the temperature conditioning system if any up to the point of a reversible attachment of the coolant lines or air ducts and the coolant mass.

Note 2 to entry: Specific energy is expressed in watt hours per kilogram (Wh/kg).

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3.20
state of charge
SOC
available capacity in a battery pack or system expressed as a percentage of *rated capacity* (3.15)

3.21
top off charge
additional charge which eliminates possible SOC reduction after SCH at RT followed by thermal equilibration at a different temperature

3.22
supplier
party that provides battery systems and packs

EXAMPLE A battery manufacturer.

3.23
voltage class A
classification of an electric component or circuit with a *maximum working voltage* (3.14) of ≤30 V a.c. (rms) or ≤60 V d.c., respectively

Note 1 to entry: See ISO 6469-3.

3.24
voltage class B
classification of an electric component or circuit with a *maximum working voltage* (3.14) of (>30 and ≤1 000) V a.c. (rms) or (>60 and ≤1 500) V d.c., respectively

Note 1 to entry: See ISO 6469-3.

4 Symbols and abbreviated terms

4.1 Symbols

C_{fade}	Capacity fade
$C_{rt,t0}$	Rated 1 C capacity at BOL
$I_{c,max}$	maximum continuous charge current specified by the supplier for energy efficiency at fast charging testing
$I_{d,max}$	maximum continuous discharge current specified by the supplier for energy and capacity testing
$I_{dp,max}$	maximum discharge pulse current specified by the supplier for power, internal resistance and energy efficiency testing
T_{max}	maximum temperature
T_{min}	minimum temperature
T	Time

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