IEC 62933-5-4

Edition 1.0 2026-05

# INTERNATIONAL STANDARD

**Electrical energy storage (ESS) systems -**
**Part 5-4: Safety test methods and procedures for grid integrated EES systems - Lithium ion battery-based systems**

ICS 27.010

ISBN 978-2-8327-1213-9

IEC 62933-5-4:2026-05(en)

**THIS PUBLICATION IS COPYRIGHT PROTECTED**
**Copyright © 2026 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 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 It also gives information on projects, replaced and withdrawn publications.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, graphical symbols and the glossary. 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 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

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

# CONTENTS

FOREWORD ..... 3
INTRODUCTION ..... 5
1 Scope ..... 6
2 Normative references ..... 6
3 Terms and definitions ..... 7
4 Manufacturer ..... 9
5 Test methods and procedures for EES system ..... 10
5.1 General ..... 10
5.2 Electrical hazards test method and procedure ..... 11
5.2.1 High current discharge (short-circuit) protection ..... 11
5.2.2 Overcharge, high current charge and earth fault protection ..... 15
5.3 Explosion hazards test method and procedure ..... 19
5.3.1 Analysis of flammable gas from a cell ..... 19
5.3.2 Gas detection system ..... 21
5.3.3 Ventilation ..... 23
5.3.4 Ventilation capability ..... 23
5.4 Hazards arising from electric, magnetic, and electromagnetic fields – Test method and procedure ..... 24
5.4.1 Electromagnetic emission test – General ..... 24
5.4.2 Test method ..... 24
5.4.3 Electromagnetic immunity ..... 25
5.5 Hazards arising from auxiliary, control and communication system malfunctions test method and test procedure ..... 28
5.5.1 General ..... 28
5.5.2 Communication errors ..... 29
Annex A (informative) Deflagration venting ..... 32
A.1 General ..... 32
A.2 Physical verification ..... 32
A.2.1 Test method ..... 32
A.2.2 Acceptance criteria ..... 32
A.3 Simulation verification ..... 32
A.3.1 Modelling method ..... 32
A.3.2 Acceptance criteria ..... 33
Annex B (informative) Fire hazard test method and procedure for BESS-level evaluation ..... 34
B.1 Objective ..... 34
B.2 Fire initiation method (thermal runaway of a single module) ..... 34
B.3 Fire test conditions ..... 34
B.4 Acceptance criteria ..... 34
Annex C (informative) Relation of IEC 62933-5-4 test items to IEC 62933-5-2 ..... 35
Bibliography ..... 36

Figure 1 – Representative example on composition of circuits for short-circuit test – AC short circuit ..... 13
Figure 2 – Representative example on composition of circuits for short-circuit test – DC short circuit ..... 13

Figure 3 – Representative example on composition of circuits for short-circuit test – Switching element short-circuit ..... 13
Figure 4 – Representative example on composition of circuits for short-circuit test – External short-circuit in one of the battery racks ..... 14
Figure 5 – Representative example on composition of circuits for earth fault – AC earth fault ..... 18
Figure 6 – Representative example on composition of circuits for earth fault – DC earth fault ..... 18
Figure 7 – Example of an abuse chamber used for several battery cells testing ..... 20
Figure 8 – Example on the position of sensors used in gas/off-gas detection test ..... 22
Figure 9 – Measurement point for conducted emission at DC port of PCS ..... 25
Figure 10 – Example of damped oscillatory wave in accordance with IEC 61000-4-18 ..... 26
Figure 11 – Test point for damped oscillatory wave immunity on communication cable ..... 27
Figure 12 – Example of test setup for damped oscillatory wave immunity test ..... 27
Figure 13 – Test structure of communication detect error ..... 30

Table 1 – Testing list of lithium ion battery-based BESS ..... 11
Table 2 – Criteria to pass short-circuit tests ..... 15
Table 3 – Voltage limits or current limits ..... 24
Table 4 – Values of the parameters of $w(t)$ for each standard oscillation frequency ..... 26
Table 5 – Examples on resistance values per each fault mode ..... 30
Table C.1 – Correspondence between IEC 62933-5-4 test items and IEC 62933-5-2 ..... 35

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

# Electrical energy storage (EES) systems - Part 5-4: Safety test methods and procedures for grid integrated EES systems - Lithium ion battery-based systems

## 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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62933-5-4 has been prepared by IEC technical committee 120: Electrical Energy Storage (ESS) systems. It is an International Standard.

This International Standard is to be used in conjunction with IEC 62933-5-2:2025.

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

| Draft | Report on voting |
|---|---|
| 120/448/FDIS | 120/456/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 62933 series, published under the general title *Electrical energy storage (EES) 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, or
– revised.

# INTRODUCTION

The general safety requirements for EES systems are provided in IEC 62933-5-1. The safety requirements for battery energy storage systems (BESS) with subsystems utilizing electrochemical-based batteries are described in IEC 62933-5-2. In this document, among the safety provisions specified in IEC 62933-5-2, tests methods and procedures specific to the safety of BESS using lithium ion batteries in the subsystem are specified. This document is prepared for the following reasons:

a) To provide additional test methods and procedures specifically for lithium ion battery-based energy storage systems.

b) This document was developed based on the investigation results of BESS accidents that occurred over the world.

## 1 Scope

This part of IEC 62933 primarily describes the safety test methods and procedures for grid-connected energy storage systems where a lithium ion battery-based subsystem is used.

This document provides test methods and procedures to validate safety issues specifically related to the use of a lithium ion battery-based subsystem, primarily based on IEC 62933-5-1, which establishes criteria for ensuring the safe applications and use of electrical energy storage systems of any type or size, and IEC 62933-5-2, which further specifies safety provisions arising from the use of an electrochemical storage subsystems in EES systems.

All test methods and procedures are based on the requirements of IEC 62933-5-2. This document includes only the test methods specifically related to lithium ion battery-based BESS and is based on actual tests.

## 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 60079-29 (all parts), *Explosive atmospheres - Gas detectors*

IEC 60730-1, *Automatic electrical controls - Part 1: General requirements*

IEC 61000-4-18, *Electromagnetic compatibility (EMC) - Part 4-18: Testing and measurement techniques - Damped oscillatory wave immunity test*

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 62933-1, *Electrical energy storage (EES) systems - Part 1: Vocabulary*

IEC 62933-5-1, *Electrical energy storage (EES) systems - Part 5-1: Safety considerations for grid integrated EES systems - General specification*

IEC 62933-5-2:2025, *Electrical energy storage (EES) systems – Part 5-2: Safety requirements for grid-integrated EES systems – Electrochemical-based systems*

IEC 63056, *Secondary lithium cells and batteries for use in electrical energy storage systems - General requirements and methods of test*

CISPR 11, *Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement*

CISPR 16-1-2, *Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-2: Radio disturbance and immunity measuring apparatus - Coupling devices for conducted disturbance measurements*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62933-1, IEC 62933-5-1, IEC 62933-5-2 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

**3.1**
**state of charge**
**EESS SOC**
amount of stored electric charge (IEV 113-02-10) of the accumulation subsystem, related to the actual capacity (IEV 482-03-14)

Note 1 to entry: The EESS SOC is frequently intended as a synonym of EESS state of energy and, therefore, evaluated at EES system level. As defined in IEC 61427-2 and in many other standards the state of charge is related to electric charge (IEV 113-02-10), usually expressed in coulombs (C) or amperes-hours (Ah) and should be used only for some storage technologies (e.g. batteries, capacitors).

[SOURCE: IEC 61427-2:2015, 3.42, modified – original definition has been particularized for the EES system, the notes to entry have been removed and a new note has been added.]

**3.2**
**state of energy**
**EESS SOE**
ratio between the available energy from an EES system and the actual energy storage capacity

Note 1 to entry: The state of energy is generally expressed in percentage. ESS system empty implies EESS SOE = 0 % (empty state of energy) and EES system full implies EESS SOE = 100 % (full state of energy).

Note 2 to entry: The state of energy can be linked to accessible energy storage capacity or effective energy storage capacity. The relation with effective energy storage capacity is different. In the case of state of energy related to accessible energy storage capacity, fixed energy reserves are present on both sides (below the empty state of energy and above the full state of energy); for example, by considering the above-mentioned state of charge, its range related to accessible energy storage capacity is 0 % ÷ 100 %, so the range linked to effective energy storage capacity can be -20 % ÷ 120 %.

Note 3 to entry: In the calculation of EESS SOE linked to accessible energy storage capacity ($SOE_{US}$), the actual energy storage capacity linked to accessible energy storage capacity with the used energy storage capacity is used. In the calculation of EESS SOE linked to effective energy storage capacity ($SOE_{EFF}$), the actual energy storage capacity linked to effective energy storage capacity with the used energy storage capacity is used. In the calculation of EESS SOE linked to output energy storage capacity ($SOE_{OUT}$), the actual energy storage capacity linked to output energy storage capacity with the available energy during discharge is used. In the calculation of EESS SOE linked to input energy storage capacity ($SOE_{IN}$), the actual energy storage capacity linked to input energy storage capacity with the available energy during discharge is used.

$$SOE_{US} = \frac{E_{A,SDE}}{E_{C,ACT,US}} \qquad SOE_{EFF} = \frac{E_{A,SDE}}{E_{C,ACT,EFF}} \qquad SOE_{IN} = \frac{E_{A,DIS}}{E_{C,IN}} \qquad SOE_{OUT} = \frac{E_{A,DIS}}{E_{C,OUT}}$$

Only $SOE_{US}$ and $SOE_{OUT}$ can reach the entire interval 0 % ÷ 100 %, $SOE_{EFF}$ (because of the non useful energy) and $SOE_{IN}$ (because of energy losses) cannot reach the 100 %.

**3.3**
**short-circuit**
accidental or intentional conductive path between two or more conductive parts forcing the electric potential differences between these conductive parts to be equal to or close to zero

[SOURCE: IEC 60050-151:2001, 151-12-04]