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INTERNATIONAL STANDARD

colour inside

Secondary cells and batteries for renewable energy storage – General requirements and methods of test – Part 2: On-grid applications



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Secondary cells and batteries for renewable energy storage – General requirements and methods of test – Part 2: On-grid applications

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SECONDARY CELLS AND BATTERIES FOR RENEWABLE ENERGY STORAGE – GENERAL REQUIREMENTS AND METHODS OF TEST –

Part 2: On-grid applications

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IEC 61427-2 edition 1.1 contains the first edition (2015-08) [documents 21/862/FDIS and 21/863/RVD] and its amendment 1 (2024-03) [documents 21/1179/FDIS and 21/1194/RVD].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 61427-2 has been prepared by IEC technical committee 21: Secondary cells and batteries.

A list of all parts in the IEC 61427 series, published under the general title *Secondary cells and batteries for renewable energy storage – General requirements and methods of test*, can be found on the IEC website.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document and its amendment 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- withdrawn, or
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SECONDARY CELLS AND BATTERIES FOR RENEWABLE ENERGY STORAGE – GENERAL REQUIREMENTS AND METHODS OF TEST

Part 2: On-grid applications

1 Scope

This part of IEC 61427 relates to secondary batteries used in on-grid Electrical Energy Storage (EES) applications and provides the associated methods of test for the verification of their endurance, properties and electrical performance in such applications. The test methods are essentially battery chemistry neutral, i.e. applicable to all secondary battery types.

On-grid applications are characterized by the fact that batteries are connected, via power conversion devices, to a regional or nation- or continent-wide electricity grid and act as instantaneous energy sources and sinks to stabilize the grid's performance when randomly major amounts of electrical energy from renewable energy sources are fed into it.

Related power conversion and interface equipment is not covered by this part of IEC 61427.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

None.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
accuracy
<of a measuring instrument>

quality which characterizes the ability of a measuring instrument to provide an indicated value close to a true value of the quantity to be measured

Note 1 to entry: This term is used in the "true" value approach.

Note 2 to entry: Accuracy is better when the indicated value is closer to the corresponding true value.

[SOURCE: IEC 60050-311:2001, 311-06-08]

3.2
accuracy class
category of measuring instruments, all of which are intended to comply with a set of specifications regarding uncertainty

[SOURCE: IEC 60050-311:2001, 311-06-09]

3.3
ambient temperature
average temperature of the air or another medium in the vicinity of the equipment

Note 1 to entry - During the measurement of the ambient temperature the measuring instrument/probe should be shielded from draughts and radiant heating.

[SOURCE: IEC 60050-826:2004, 826-10-03]

3.4
maximum ambient temperature
<for battery operation> highest ambient temperature at which the battery is operable and should perform according to specified requirements

[SOURCE: IEC 60050-426:2008, 426-20-17, modified — In the definition, “trace heating” has been replaced with “battery”.]

3.5
minimum ambient temperature
<for battery operation> lowest ambient temperature at which the battery is operable and should perform according to specified requirements

[SOURCE: IEC 60050-426:2008, 426-20-20, modified — In the definition, “trace heating” has been replaced with “battery”.]

3.6
ampere hour
quantity of electrical charge obtained by integrating the current in amperes with respect to time in hours

Note 1 to entry: The SI unit for electric charge is the coulomb (1 C = 1 As) but in practice it is usually expressed in ampere hours (Ah).

3.7
battery
two or more cells fitted with devices necessary for use, for example case, terminals, marking and protective devices

[SOURCE: IEC 60050-482:2004, 482-01-04, modified — In the definition, “one” has been replaced with “two”.]

3.8
battery management system
BMS
battery management unit
BMU
electronic system associated with a battery which monitors and/or manages its state, calculates secondary data, reports that data and/or controls its environment to influence the battery’s performance and/or service life

Note 1 to entry: The function of the battery management system can be fully or partially assigned to the battery pack and/or to equipment that uses this battery.

Note 2 to entry: A battery management system is also called a "battery management unit" (BMU).

Note 3 to entry: This note applies to the French language only.

Note 4 to entry: This note applies to the French language only.

3.9
idle state
<of a battery system> state of a battery which is fully functional but not actively delivering or absorbing energy

Note 1 to entry: Such a system can deliver and absorb energy on demand with a reaction time as required by the application.

Note 2 to entry: The reaction time can vary from a few milliseconds to a few seconds.

3.10
battery support system
BSS
group of interconnected and interactive parts that perform an essential task as a component of a battery system

Note 1 to entry: Such systems are for example electrolyte storage tanks and circulation pumps, cooling and heating devices, exhaust gas abatement systems, fire extinguishers, spill catchment systems, safety barriers, racks and similar facilities.

Note 2 to entry: This note applies to the French language only.

3.11
capacity
<of cells and batteries> quantity of electric charge which a cell or battery can deliver under specified discharge conditions

Note 1 to entry: The SI unit for electric charge, or quantity of electricity, is the coulomb (1 C = 1 As) but in practice, capacity is usually expressed in ampere hours (Ah).

[SOURCE: IEC 60050-482:2004, 482-03-14, modified — In the definition, “quantity of” has been added.]

3.12
charging
<of a battery> operation during which a secondary battery is supplied with electric energy from an external circuit which results in chemical changes within the cell and thus the storage of energy as chemical energy

Note 1 to entry: A charge operation is defined by its maximum voltage, current, duration and other conditions as specified by the manufacturer.

[SOURCE: IEC 60050-482:2004, 482-05-27, modified — Note 1 to entry has been added.]

3.13
constant power charge
<of a battery> operation in which the charge power input, i.e. the product of charge current and charge voltage, is held constant and where the current and voltage freely adjust according to polarization effects of the battery

3.14
discharge
operation by which a battery delivers, to an external electric circuit and under specified conditions, electric energy produced in the cells

[SOURCE: IEC 60050-482:2004, 482-03-23]

3.15
constant power discharge
<of a battery> operation in which the discharge power output, i.e. the product of discharge current and discharge voltage, is held constant and where the current and voltage freely adjust according to polarization effects of the battery

3.16
electrolyte
substance containing mobile ions that render it ionically conductive

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

[SOURCE: IEC 60050-482:2004, 482-02-29]

3.17
endurance
<of a battery> numerically defined performance during a given test simulating specified conditions of service

[SOURCE: IEC 60050-482:2004, 482-03-44]

3.18
endurance test
<of a battery> test carried out over a time interval to investigate how the properties are affected by the application of stated stresses and by their time duration or repeated application

[SOURCE: IEC 60050-151:2001, 151-16-22, modified — "<of a battery>" has been added before the definition and "of an item" has been deleted from the definition.]

3.19
energy
<of a battery> energy which a battery delivers under specified conditions

Note 1 to entry: The SI unit for energy is the joule (1 J = 1 Ws) but in practice, energy of a battery is usually expressed in watt hours (Wh) (1 Wh = 3 600 J).

Note 2 to entry: Such energy content is generally determined with a constant power (W) discharge.

Note 3 to entry: k or M are unit prefixes in the metric system denoting multiplication of the unit by one thousand (k) or one million (M).

[SOURCE: IEC 60050-482:2004, 482-03-21, modified —Notes 2 and 3 to entry have been added.]

3.20
actual energy
<of a battery> energy content value, determined experimentally at a defined instant of time with a constant power discharge at a specified rate to a specified final voltage and at a specified temperature

Note 1 to entry: This value is expressed in watt hours (Wh) and varies over the operational cycle or life of the battery.

3.21
final voltage
end-of-discharge voltage
cut-off voltage
end-point-voltage
U_{final}
<of a battery> specified voltage of a battery at which the battery discharge is terminated

[SOURCE: IEC 60050-482:2004, 482-03-30]

3.22
flow cell
secondary cell characterized by the spatial separation of the electrode from the fluid volumes which contain active materials

Note 1 to entry: The fluids, consisting of liquids, solutions, suspensions or gases, flow separately through the electrode spaces.

Note 2 to entry: A flow cell in which one of the active materials is, depending on the state of charge, a solid deposited on one of the electrodes, is called a hybrid flow cell.

3.23
flow battery
two or more flow cells electrically connected in series and including all components for their use as an electrochemical energy storage system

Note 1 to entry: The components can be tanks, pumps, thermal and battery management systems, piping and similar.

3.24
frequency regulation service
<with batteries> regulation mode of the electrical power grid with energy drawn from or supplied to batteries to maintain the system frequency within defined limits

Note 1 to entry: This balancing of the temporal variations of grid frequency occurs typically over time periods of the order of seconds to minutes.

3.25
full charge
<of a battery> state of charge wherein the battery has been completely charged in accordance with the manufacturer's recommended charging conditions.

3.26
full-sized battery
FSB
complete battery that meets the absolute requirements of power capability and energy content, as defined in the respective endurance test clauses

Note 1 to entry: This battery is an assembly of n cells, modules or stacks and is equipped with the relative BMS and BSS as needed.

Note 2 to entry: This note applies to the French language only.

3.27
laboratory test
<of a battery> test made under prescribed and controlled conditions that may or may not simulate field conditions

[SOURCE: IEC 60050-192:2015, 192-09-05]

3.28
load following service
<with batteries> regulation mode of the electrical power grid with energy drawn from or supplied to batteries to compensate for temporary variations in load demand

Note 1 to entry: This balancing of the temporary variations of grid load demand occurs typically over time periods of the order of a few minutes to one hour.

3.29
module
standardized and interchangeable assembly of cells connected in series and/or parallel and associated hardware designed for easy assembly into a commercial battery

3.30
operating voltage range
operating voltage limits
<of a battery> voltage range, as declared by the manufacturer, in which the battery is to be operated and performs according to specifications

3.31
maximum operating voltage
upper voltage limit
U_{max}
<of a battery> upper limit of the voltage range in which the battery is operable and performs according to specifications

3.32
minimum operating voltage
lower voltage limit
U_{min}
<of a battery> lower limit of the voltage range in which the battery is operable and performs according to specification

3.33
peak-power shaving service
load levelling service
<with batteries> process of energy demand management consisting of supplementing the energy in a localized power grid, during periods of excessive demand or instantaneous high electricity costs, with energy drawn from a battery

Note 1 to entry: The energy utilized to “shave off” the demand peak is recharged into the battery in periods of low energy demand or cheap energy supply.

Note 2 to entry: This demand peak-shaving activity lasts typically over time periods of one to several hours.

3.34
PV energy storage time-shift service
<with batteries> process of energy demand management consisting of storing photovoltaic energy in a battery for a time deferred release into a localized power grid

Note 1 to entry: This energy demand management occurs typically with a 24 h day/night rhythm.

3.35
performance
<of a battery> characteristics defining the ability of the battery to achieve the intended function

[SOURCE: IEC 60050-311:2001, 311-06-11, modified — In the definition, “measuring instrument” has been replaced with “battery”.]

3.36
performance test
test carried out to determine the electrical characteristics of a battery

3.37
secondary cell
<electrochemical> basic manufactured unit of an electrochemical system capable of storing electric energy in chemical form and delivering that electrical energy back by reconversion of its stored chemical energy.

[SOURCE: IEC 60050-811:1991, 811-20-01, modified]

3.38
service life
<of a battery> total period of useful life of a cell or battery in operation

Note 1 to entry: For secondary cells and batteries, the service life may be expressed in time, number of charge/discharge cycles, or total throughput in ampere hours (Ah).

[SOURCE: IEC 60050-482:2004, 482-03-46, modified — Note 1 to entry has been deleted.]

3.39
maximum service temperature
maximum operating temperature
maximum permissible temperature
<of a battery> highest temperature which the battery is allowed to attain in normal use as a result of ambient temperatures, induced heat and heat caused by the battery itself

[SOURCE: IEC 60050-442:1998, 442-06-41, modified — In the definition, “connecting device” has been replaced with “battery”.]

3.40
minimum service temperature
minimum operating temperature
minimum permissible temperature
<of a battery> lowest temperature which the battery is allowed to attain in normal use as a result of ambient temperatures and forced cooling

3.41
stack
<of a flow battery> two or more flow cells connected in series or in parallel with associated electrical connections and fluid piping

3.42
state of charge
SoC
<of a battery> amount of stored charge in ampere hours (Ah) or energy in watt hours (Wh) related to the actual capacity or energy content

Note 1 to entry: This definition is applicable throughout and only to this part of IEC 61427.

Note 2 to entry: State of charge is expressed as a percentage.

Note 3 to entry: This note applies to the French language only.

3.43
target operational state of charge
SoC_{OT}
<of a battery> pre-defined state of charge to which the energy storage system is driven by a controller or BMS under pre-defined conditions

Note 1 to entry: This SoC_{OT} is to be attained or/and maintained when bidirectional energy transfers to and from the battery are to be achieved within set voltage and SoC limits.

Note 2 to entry: State of charge is expressed as a percentage.

Note 3 to entry: SoC_{OT} is typically the desired or recommended average operating SoC during the specified application scenario. It is selected to improve electrical energy storage (EES) system performance and/or improve the EES system service life in the specified application.

3.44
test
<of a battery> technical operation that consists of the determination of one or more characteristics of a given battery according to a specified procedure

Note 1 to entry: A test is carried out to measure or classify a characteristic of a property of a battery by applying to the battery a set of environmental and operating conditions and/or requirements.

[SOURCE: IEC 60050-151:2001, 151-16-13, modified — In the definition, “product, process or service” has been replaced with “battery”.]

3.45
test object
item submitted to a test, including any accessories, unless otherwise specified

[SOURCE: IEC 60050-151:2001, 151-16-28]

3.46
test object battery
TOB
assembly of $x \times 1/n$ units consisting of cells, modules or stacks of the full-sized battery (FSB), which when assembled in n units, form the FSB which meets the absolute requirements of power capability and energy content as defined in the respective endurance test clauses

Note 1 to entry: The test object battery (TOB) is fully representative of the full-sized battery (FSB) in terms of scalability so that obtained test results can be generalized accurately to the FSB.

Note 2 to entry: The TOB is equipped with the relative BMS and BSS as needed.

Note 3 to entry: This note applies to the French language only.

3.47
time-shift service
<with batteries> process of energy demand management consisting in providing to the grid, at suitable moments, energy stored in batteries at times of ample production or weak demand

Note 1 to entry: This supplying of energy to the grid occurs over time periods typically of the order of a few hours, days or even seasons.

4 General considerations

The supply of energy from renewable energy sources such as wind, solar radiation or tidal forces is characterized by a high degree of intermittency and a low degree of predictability. When their output is fed into the power transmission and distribution grid, overload and instability conditions may develop which make it highly desirable to use rechargeable batteries to temporarily store this energy and then release it in a controlled fashion to smooth and stabilize the flow of power in the grid.

Such instabilities and imbalances in power grids may also result when insufficient power generation capability is present.

The aim of this part of IEC 61427 is to advise and guide future system operators to identify and select suitable rechargeable batteries for grid-connected electrical energy storage (EES). This process will be aided by a set of common test methods that quantify the capability of battery systems of different chemistries and designs in a particular application scenario.

The requirements for battery endurance and electrical performance are linked to the specific EES scenarios to be implemented for the management of excess energy in the grid and the associated capital and operating expenditures for such an installation.