IEC TS 62933-3-1

Edition 1.0 2018-08

TECHNICAL SPECIFICATION

colour inside

Electrical energy storage (EES) systems – Part 3-1: Planning and performance assessment of electrical energy storage systems – General specification

IEC TS 62933-3-1:2018-08(en)

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 corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

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 It also gives information on projects, replaced and withdrawn publications.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

Electropedia - www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

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 TS 62933-3-1

Edition 1.0 2018-08

TECHNICAL SPECIFICATION

colour inside

Electrical energy storage (EES) systems – Part 3-1: Planning and performance assessment of electrical energy storage systems – General specification

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 13.020.30

ISBN 978-2-8322-5973-3

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

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 3-1: Planning and performance assessment of electrical energy storage systems – General specification

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.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical Specification IEC 62933-3-1 has been prepared by IEC technical committee TC 120: Electrical Energy Storage (EES) Systems.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
120/118/DTS	120/123/RVDTS

Full information on the voting for the approval of this technical specification 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 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 publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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.

INTRODUCTION

IEC 62933-2-1 should be used as a reference when selecting testing items and their corresponding evaluation methods as well as principal parameters. Principal terms used in this document are defined in IEC 62933-1. Environmental issues are covered by IEC TS 62933-4-1. The personnel safety issues are covered by IEC TS 62933-5-1.

ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 3-1: Planning and performance assessment of electrical energy storage systems – General specification

1 Scope

This part of IEC 62933 is applicable to EES systems designed for grid-connected indoor or outdoor installation and operation. This document considers

- necessary functions and capabilities of EES systems
- test items and performance assessment methods for EES systems
- requirements for monitoring and acquisition of EES system operating parameters
- exchange of system information and control capabilities required

Stakeholders of this document comprise personnel involved with EES systems, which includes

– planners of electric power systems and EES systems
– owners of EES system
– operators of electric power systems and EES systems
– constructors
– suppliers of EES system and its equipment
– aggregators

Use-case-specific technical documentation, including planning and installation specific tasks such as system design, monitoring and measurement, operation and maintenance, are very important and can be found throughout this document.

NOTE This document has been written for AC grids, however parts can also apply to DC grids.

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 60721-1, *Classification of environmental conditions – Part 1: Environmental parameters and their severities*

IEC 62351 (all parts), *Power systems management and associated information exchange – Data and communications security*

IEC 62443 (all parts), *Industrial communication networks – Network and system security*

IEC 62933-1:2018, *Electrical energy storage (EES) systems – Part 1: Vocabulary*

IEC 62933-2-1, *Electrical energy storage (EES) systems – Part 2-1: Unit parameters and testing methods – General specification*

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

ISO/IEC 27000, *Information technology – Security techniques – Information security management systems – Overview and vocabulary*

3 Terms, definitions and symbols

3.1 Terms and definitions

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

3.1.1
idle, adj.
<period of time> time period where the EES system does not or is not able to perform any grid tasks related to active output power at the point of connection (POC)

3.1.2
recovery time
duration needed by an EES system to recover from a duty cycle so that the following duty cycle is within its specified conditions for a certain operating mode and at continuous operating conditions

Note 1 to entry: The definition is loosely based on IEC 60050-447:2010, 447-05-08.

3.2 Symbols

P active power

Q reactive power

S apparent power

U voltage

I current

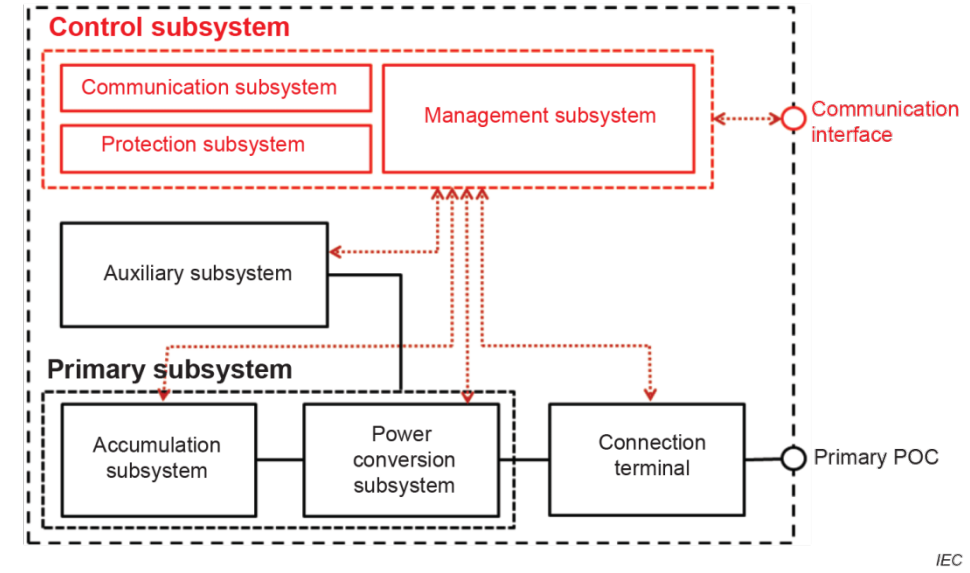
$\cos\varphi$ power factor

f frequency

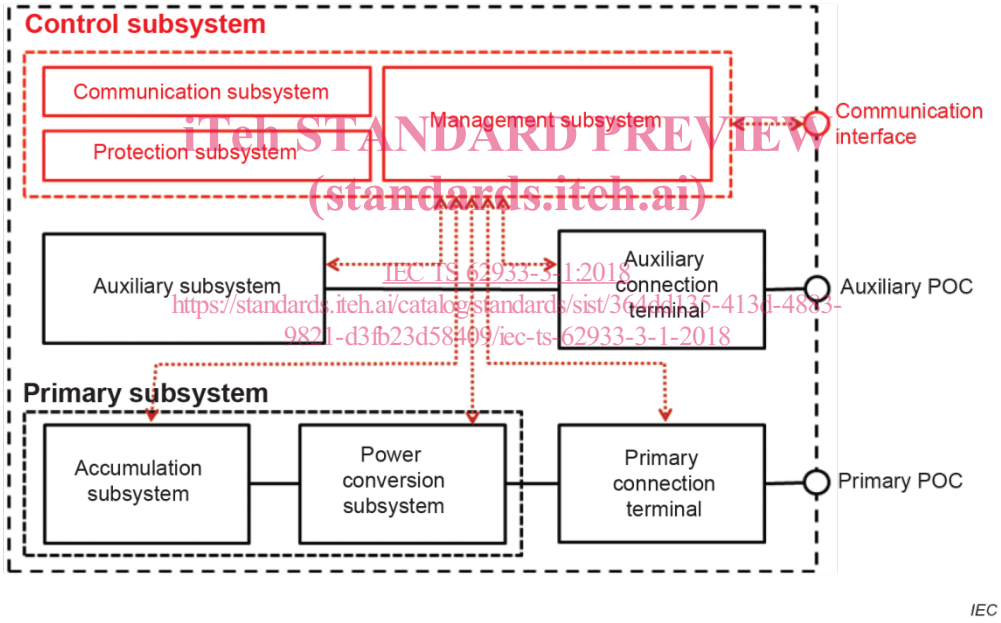
4 General structure of EES systems

4.1 Architecture of an EES system

The typical architecture of an EES system, which internally feeds the auxiliary subsystem, is given in Figure 1 a).



a) EES system without auxiliary POC



b) EES system with auxiliary POC

Figure 1 – Typical architectures of EES systems

If the auxiliary subsystem is fed from another feeder, the optional architecture of an ESS system is shown in Figure 1 b).

In 4.2 the subsystems of an EES system are described. In general, for all subsystems, the contribution to the overall system efficiency, for example roundtrip efficiency, shall be indicated.

4.2 Subsystem specifications

4.2.1 Accumulation subsystem

The energy capacity of the accumulation subsystem of the EES system has to be evaluated in an appropriate way with respect to the energy form. The energy capacity of the accumulation subsystem directly influences the rated input and output energy capacity at the primary POC,

i.e. it influences the active input and output power values at the primary POC as well as the duration the active input and output power can be applied at the primary POC.

A widely-used approach for classifying EES systems is the determination according to the form of energy used in the accumulation subsystem. A classification example of EES systems according to energy form in the accumulation subsystem is shown in Figure 2.

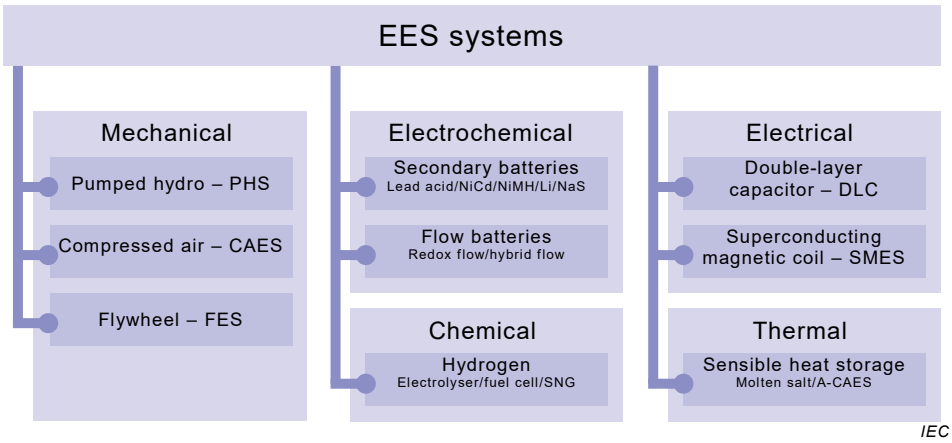


Figure 2 – Example of classification of EES systems according to energy form

4.2.2 Power conversion subsystem

The power conversion subsystem converts the power of the accumulation subsystem into electrical power at the POC, typically AC output power during discharge of the accumulation subsystem, and can convert grid AC input power to suitable power for charging the accumulation subsystem. This conversion can be performed by electrical and/or mechanical systems. The power conversion subsystem influences the apparent power characteristic of the EES system. The power conversion subsystem can also influence the power quality at the POC.

Generally the power conversion subsystem is connected to the accumulation subsystem and to the (primary) connection terminal. For planning issues the power conversion subsystem shall also include all power transfer apparatus between the connection terminal and the accumulation subsystem, for example any kind of power transformer, sine filter or switching elements.

4.2.3 Auxiliary subsystem

All necessary equipment intended to perform EES system auxiliary functions shall be used, for example heating, ventilation, fire suppression system and air conditioning system.

4.2.4 Control subsystem

A system for monitoring and controlling the EES system shall be used. A control subsystem may include a communication subsystem, protection subsystem and management subsystem. During the planning phase the required remote control capabilities and the operation modes that the control system will support shall be stated, considering the applicable local grid code requirements.

The EES system shall be designed in such a way that a supply outage does not affect the EES system security and the ability of the EES system to start up again. The maximum outage duration should be considered (for example a specific back-up power has to be designed). A safe disconnection and safe system shutdown concept shall be agreed between the supplier and user of the EES system.

All protection functions shall be described with functionality and trigger values.

5 Planning of EES systems

5.1 General

The planning of an EES system is dependent on the topology of the grid as well as on the power demand and generation available at the POC. There is a wide variety of grids that have EES systems connected. These variations impact EES system specifications including:

- functionality (peak shaving, frequency support, virtual synchronous machine behaviour, etc.),
- accumulation subsystem (energy capacity, power, etc.),
- power conversion subsystem (response time, droop control, power, short-circuit power, etc.).

The EES system requirements should be clearly outlined in order to provide the best solution and to maximize system adaptability and performance benefits. The needs of the electrical network may also need to be considered. During the planning phase, at the system level and after the application has been defined, the EES system requirements have to be specified according to the application.

The results of the sizing of EES systems (examples are given in Annex A) are the relevant parameters of the EES system including:

– rated input and output power
– short duration input and output power
– rated energy capacity
– response time parameters
– auxiliary power consumption
– self-discharge
– roundtrip efficiency
– duty cycle roundtrip efficiency
– recovery times
– end-of-service life values

Clause 5 helps the planner define the specifications in such a way that EES system suppliers have all the relevant information to design a system.

Clause 5 provides information needed to assess the performances of a system. This ensures that potential users (such as a utility) can have the necessary information about the EES system from the system supplier. In particular maintenance requirements and end-of-service life values shall be provided and be compatible with the application.

In general the rated value of a quantity is used for specification purposes, established for a specified set of operating conditions of a component, device, equipment, or system. When specifying the rated values for planning purposes of an EES system, the critical operating limits of the power capability chart, capability reductions due to ageing, altered environmental conditions and other limiting factors shall be taken into account. All rated values used for planning purposes shall be values related to the end-of-service life.

Other parameters such as availability shall be provided and taken into account during the planning phase.

Auxiliary power consumption varies throughout the service life of the EES system and shall therefore be assessed for the whole service life of the unit and for the environmental conditions expected at the installation site. The influence on the overall EES system efficiency of the extreme weather conditions should also be considered (see 5.2.3).

NOTE End-of-service life value definitions are given in IEC 62933-1. The test of auxiliary power consumption is included in IEC 62933-2-1.

5.2 EES system environment

5.2.1 General

Subclause 5.2 describes the environment of the EES system, which shall be considered for planning an EES system. Subclause 5.2 contains three further subclauses:

- grid parameters and requirements, which include mainly electrical parameters, constraints, operational ranges and requirements of the electrical power grid at the (primary) POC (5.2.2),
- service conditions, which include the non-electrical environment of the EES system (5.2.3),
- standards and local regulations, which include additional requirements according to applicable standards and regulations (5.2.4).

According to the place of installation the site-specific requirements shall be considered during the planning phase. Examples of site-specific requirements of an EES system are given in Annex B.

In addition, the classification of environmental conditions in IEC 60721-1 shall be considered in the planning phase.

5.2.2 Grid parameters and requirements

5.2.2.1 Grid parameters

The main parameters of the grid at the POC, to which the EES system is going to be connected, shall be considered in the planning phase. These parameters include

- nominal voltage of the service
- highest voltage for components
- temporary voltage variations
- nominal frequency
- continuous normal frequency variation
- temporary frequency variations
- short-circuit current and duration
- neutral connection

These parameters are typically provided by the grid operator and may be included in specific grid requirements based on local grid codes.

5.2.2.2 Protective earthing

For earthing, refer for example to IEC 60364 (all parts) and local regulations.

5.2.2.3 Emissions and disturbances of the EES system at the POC

The contribution to harmonic voltage and current disturbances or other undesired effects at the POC of the EES system shall be declared clearly by the system supplier to assess possible issues with grid codes already at the planning stage (see also IEC 62933-2-1 for appropriate testing).