PD IEC TS 62933-3-1:2018

BSI Standards Publication

Electrical energy storage (EES) systems

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

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National foreword

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TECHNICAL SPECIFICATION

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

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

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

FOREWORD

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- 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.

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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- withdrawn,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.

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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.

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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*

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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).

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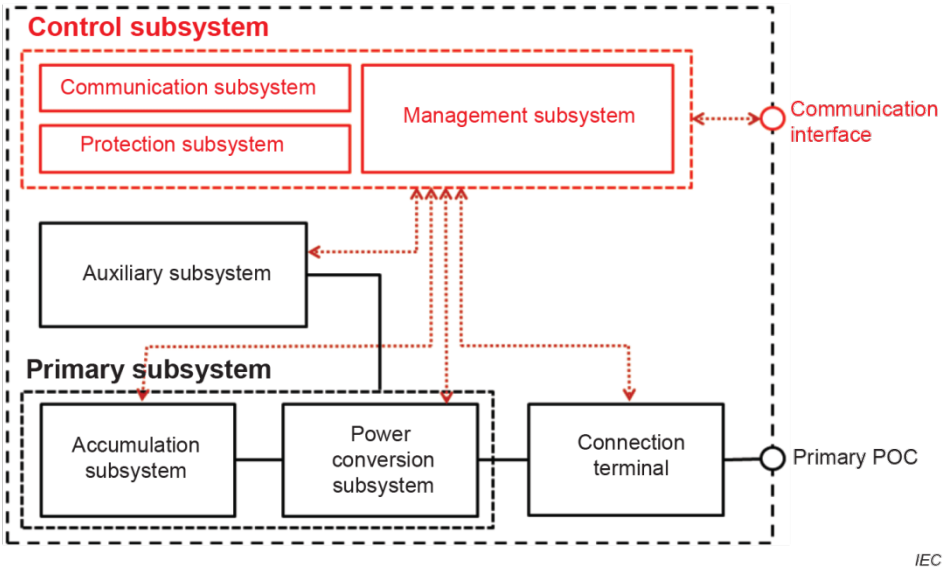
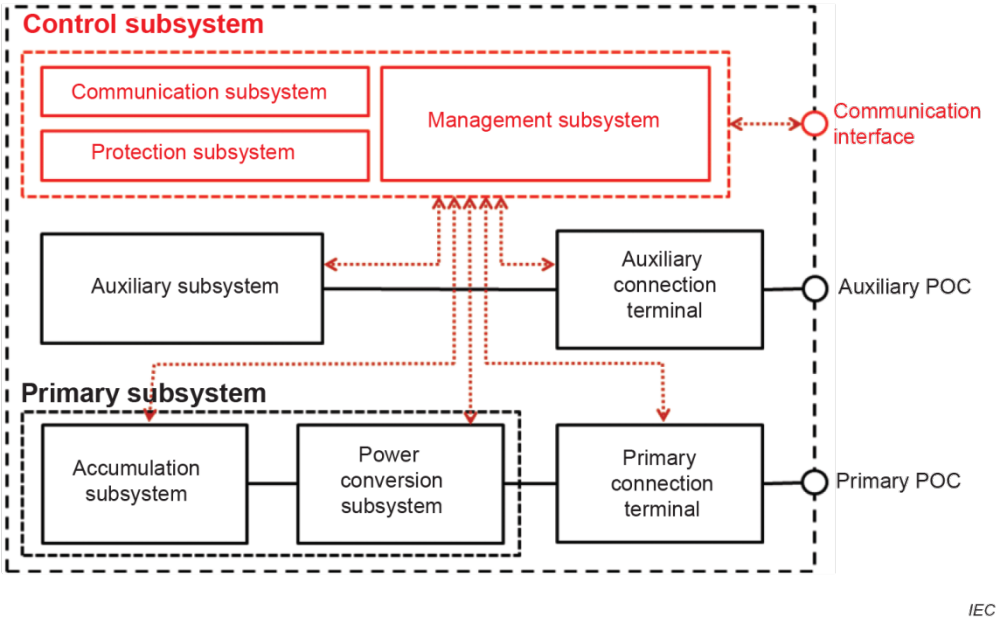


a) EES system without auxiliary POC



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.

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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.

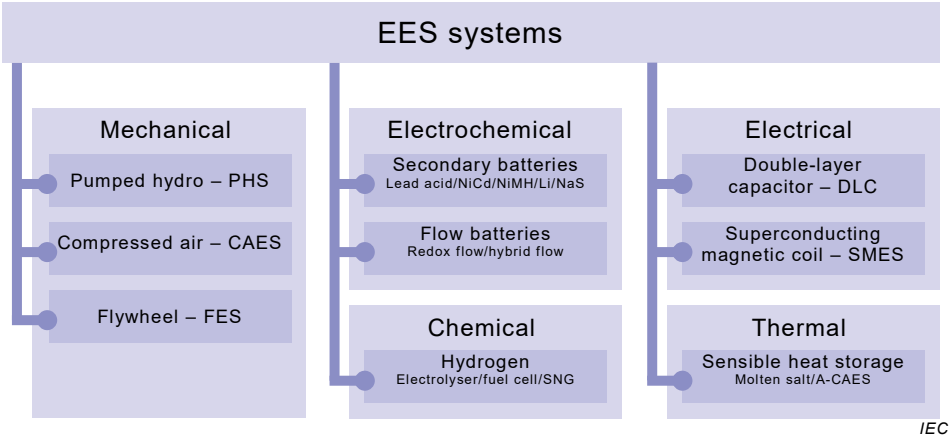

Figure 2 – Example of classification of EES systems according to energy form

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.

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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.

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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).

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5.2.2.4 Immunity of the EES system

The EES system shall be immune against possible, harmful impacts from the electrical environment. For example, in EMC-sensitive cases, such as the installation of an EES system in a substation, the EES system should implement an immunity level according to the requirements stated in IEC 61000-6-5.

5.2.3 Service conditions

5.2.3.1 General

Subclause 5.2.3 includes all non-electrical environmental conditions such as altitude, humidity, etc.

Where applicable, EES system planners should refer to IEC 60721-3-3, IEC 60364-5-51 or IEC TS 62933-4-1 for guidelines on environmental conditions.

5.2.3.2 Earthquake resistivity and endurance

Where appropriate the EES system and its support structure shall withstand earthquakes. In general the EES system and its support structure should be designed in accordance with the seismic classification area of the site and local codes. The EES system should achieve at least the same performance against earthquakes than the rest of the grid equipment.

For soil acceleration levels, as well as test methods, refer to IEC 60068-3-3 and local regulations. Additionally local conditions, for example environmental conditions, shall be taken into account.

Where an earthquake-proof standard is specified, the EES system should comply with this standard. However, where a large influence by vibration is expected, additional standards and measures should be considered.

5.2.3.3 Ambient temperature and solar radiation

The EES system shall be designed and constructed to withstand the stress generated due to temperature variation considering the effects of the ambient temperature and the solar radiation on the operating temperature. Unless specifically ordered otherwise by the customer, the cooling/heating system shall be sized appropriately while considering the most demanding operational and weather conditions of the site.

5.2.3.4 Protection against dust and corrosive atmospheres

Where required, the EES system shall be equipped with protection against dust and corrosive atmospheres according to the operating environment. The structure of the EES system shall be easily maintained.

5.2.3.5 Inundation

If required, the measures against flood according to local regulations shall be applied. These regulations can depend on installation conditions such as location, characteristics of the region and principle and scale of the EES system. Where flood protection measures are specified by local regulation, the EES system should comply with that regulation. However, where flooding probability is not negligible, protective measures should be applied irrespective of the absence of a local regulation.

5.2.3.6 Wind

If required, the wind protection measures should conform to related regulations depending on installation conditions such as location, characteristics of the region, principle and scale of the EES system. In case wind protection measures are specified by local regulation, the EES

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system should comply with that regulation. However, where large influence by wind is expected, protective measures should be applied irrespective of the absence of a local regulation.

5.2.4 Standards and local regulations

5.2.4.1 General impact on EES system design

All standards and local regulations which impact EES system design shall be explored in the planning phase.

5.2.4.2 Emissions of EES system

To minimize the influence on the environment caused by the installation of an EES system, two categories should be considered. Specifically, one category is a regular occurrence, such as noise exhaust gas and EMC; the other category is an irregular occurrence, such as fire, explosion collapse and disposal. For environmental impacts refer to IEC TS 62933-4-1; for safety refer to IEC 62933-5 (all parts) and for EMC emissions refer to IEC 61000-6-4.

5.3 Sizing of EES systems

5.3.1 Requirements at primary POC

Sizing of EES systems is usually connected to the identification of one or more suitable duty cycles, which the EES system may typically have to perform at the primary POC to meet its operational requirements. Additionally it is necessary to know the (minimum and maximum) recovery times which are available to restore the EES system between duty cycles. In addition, the required service life time of the EES system should be specified with regard to the proper consideration of system ageing and possibly necessary maintenance and refurbishment works.

The specification of identified duty cycles should include

- duration of the duty cycle and the expected frequency (number of times per day/week/year);
- required pattern of the active power at the primary POC of the EES system, possibly including allowed tolerance ranges (maximum overshoot and/or undercut);
- required pattern of the reactive power at the primary POC of the EES system, possibly including allowed tolerance ranges (maximum overshoot and/or undercut).

The specified pattern of active and reactive power at the primary POC can include durations in which active and/or reactive power is zero. From these patterns it should be possible to derive ramp rates of active and reactive power.

Since the initial value at the beginning of each duty cycle should be within a certain energy content range, a recovery cycle may be necessary to bring back the EES system to a state where it is possible to perform duty cycles again. The degrees of freedom in recovery cycles depend mainly on grid requirements. With regard to sizing the EES system, the following characteristic values of the recovery process should be given:

a) minimum duration

b) maximum duration

c) range of allowed active output or input power, including maximum and minimum active output or input power values

d) possible requirements or constraints regarding reactive input and output power

e) maximum allowed ramp rates of active and reactive power

f) allowed range of power factor values at primary POC

g) possible requirements regarding power factor

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