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INTERNATIONAL STANDARD

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

Systèmes de stockage de l'énergie électrique (EES) – Partie 2-1: Paramètres unitaires et méthodes d'essai – Spécifications générales

IEC 62933-2-1:2017-12(en-fr)

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ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 2-1: Unit parameters and testing methods – General specification

FOREWORD

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

FDIS	Report on voting
120/109/FDIS	120/115/RVD

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of January 2019 have been included in this copy.

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ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 2-1: Unit parameters and testing methods – General specification

1 Scope

This part of IEC 62933 focuses on unit parameters and testing methods of EES systems. The energy storage devices and technologies are outside the scope of this document. This document deals with EES system performance defining:

– unit parameters,

– testing methods.

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 60364-6, *Low voltage electrical installations – Part 6: Verification*

IEC 61000-4-7, *Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto*

IEC 61400-21, *Wind turbines – Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines*

IEC TR 61850-90-7, *Communication networks and systems for power utility automation – Part 90-7: Object models for power converters in distributed energy resources (DER) systems*

IEC 61936-1, *Power installations exceeding 1 kV a.c. - Part 1: Common rules*

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

3 Terms, definitions, abbreviated terms and symbols

3.1 Terms and definitions

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

[1] Under preparation. Stage at the time of publication: IEC FDIS 62933-1:2017

3.2 Abbreviated terms

CAES	compressed air energy storage
CB	circuit breaker
DLC	double layer capacitor
EES	electrical energy storage
FES	flywheel energy storage
NaS	sodium sulphur
NiCd	nickel cadmium
NiMH	nickel metal hydride
PHS	pumped hydro storage
POC	point of connection
SMES	superconducting magnetic energy storage
SNG	synthetic natural gas
SOC	state of charge

3.3 Symbols

η_{rt}	roundtrip efficiency
E_o	total output energy measured at POC
E_I	total input energy measured at POC
E_{aux_o}	energy consumption of auxiliary subsystem measured at auxiliary POC during output operation
E_{aux_I}	energy consumption of auxiliary subsystem measured at auxiliary POC during input operation
RR	ramp rate
SRT	step response time
P	active power
Q	reactive power
S	apparent power
U	voltage
I	current
P_{aux}	auxiliary power consumption

4 Classification of EES system

4.1 General

A widely-used approach for classifying EES systems is the determination according to the form of energy used. A classification example of EES systems according to energy form is shown in Figure 1. EES systems are classified into mechanical, electrochemical, chemical, electrical and thermal energy storage systems.

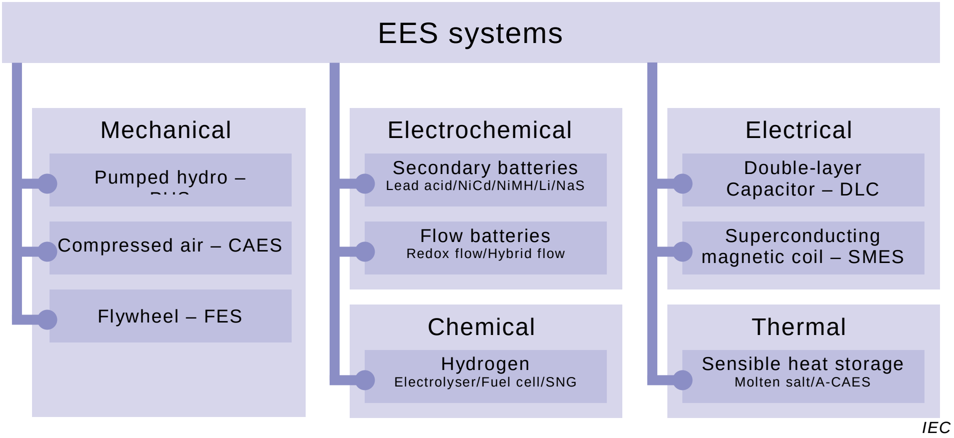

Figure 1 – Example of classification of EES systems

4.2 Categorizing the application of EES system

The application and use of an EES system differs according to its purpose and location. The application of an EES system can be classified into three classes, and five representative applications are described in Table 1. The summary of the three classes of Table 1 is as follows:

a) Class A: short-duration application that requires the EES system to input/output the required power over a duty cycle for a short period of time (for example, the EES system is charged and discharged in less than 1 h).
b) Class B: long-duration application that requires the EES system to input/output the required power over a duty cycle for a long period of time (for example, the EES system is charged and discharged in more than 1 h).
c) Class C: the EES system is used to supply AC power to electric power grids in emergency case, without relying on an external power source.

One EES system can be used in combination with applications of different classes.

Table 1 – Example of typical and not exclusive applications classification

Classifications	Class A (short duration)	Class B (long duration)	Class C (back-up)
Typical applications	Frequency regulation Fluctuation reduction Voltage regulation	Peak shaving/peak shifting	Back-up power

4.3 Class A applications

4.3.1 Frequency regulation

The EES system supports grid frequency stabilization using active power.

4.3.2 Fluctuation reduction

The EES system stabilizes a fluctuating power supply or a fluctuating load.

4.3.3 Voltage regulation

The EES system stabilizes the voltage of a power grid using reactive and active power.

4.4 Class B – Peak shaving/peak shifting

The EES system has a function to use the stored energy for peak demand or a function to store excess energy of generation. EES system can achieve better operation efficiency of the transmission and distribution lines.

4.5 Class C – Back-up power

The EES system has a function to supply AC power in electric power grids or microgrids installed to operate critically important systems over a fixed duration in accordance with the system specifications. ESS system can therefore reduce the risk of major blackouts.

5 Unit parameters

5.1 General

5.1.1 Overview

The following parameters shall be specified as the common basic parameters to ensure EES system capability and performance:

- nominal energy capacity (Wh);
- input and output power rating (W, var, VA);
- roundtrip efficiency (%);
- expected service life (years, duty-cycles);
- system response (step response time (s) and ramp rate (W/s));
- auxiliary power consumption (W);
- self-discharge of EESS (Wh/h);
- voltage range (V);
- frequency range (Hz).

Each parameter defined in this document shall be measured and evaluated at the POC.

5.1.2 Reference environmental conditions

The EES system shall be used under the conditions listed in Table 2.

Table 2 – Normal environmental conditions

		Indoor installation	Outdoor installation
Ambient air temperature	Upper limit	≤ 40 °C	≤ 40 °C
	and 24 h average	≤ 35 °C	≤ 35 °C
	and one category: or or	-5 indoor: ≥ −5 °C -15 indoor: ≥ −15 °C -25 indoor: ≥ −25 °C	-10 outdoor: ≥ −10 °C -25 outdoor: ≥ −25 °C -40 outdoor: ≥ −40 °C
Solar radiation (clear day, noon)		Negligible	≤ 1 000 W/m[a] [b]
Altitude		≤ 1 000 m	≤ 1 000 m
Relative humidity: 24 h average		≤ 95 % [b]	
Condensation, precipitation			[c]

[a] Details of global solar radiation are given in IEC 60721-2-4. Ultraviolet (UV) radiation can damage some synthetic materials, for more details see IEC 60068.

[b] For these conditions, condensation may occasionally occur. Condensation can be expected where sudden temperature changes occur in periods of high humidity. To avoid breakdown of insulation or corrosion of metallic parts due to high humidity and condensation, equipment designed for such conditions and tested accordingly should be used. Condensation may be prevented by special design of the building or housing, by suitable ventilation and heating of the station or by the use of dehumidifying equipment.

[c] Precipitation in the form of dew, condensation, fog, rain, snow, ice or hoar frost should be taken into account. Precipitation characteristics for insulation are described in IEC 60060-1 and IEC 60071-1. For other properties, precipitation characteristics are described in IEC 60721-2-2.

When the EES system is intended to be used under conditions different from the normal environmental conditions given in Table 2, an agreement between user and system supplier is necessary. For each test described in this document, the system supplier shall report the following environmental conditions:

a) ambient air temperature

b) altitude

c) relative humidity/condensation and precipitation (precipitation is only needed for outdoor equipment)

d) Atmospheric pressure

5.1.3 Standard testing conditions

The EES system shall be tested under the conditions listed in Table 3. However, if it cannot be tested under standard test conditions, conversion to standard test conditions is allowed.

Table 3 – Standard testing conditions

Item	Conditions
Ambient air temperature	25 ºC
Altitude	≤ 1 000 m
Humidity	≤ 95 % with no condensation

5.1.4 Typical architecture

The typical architecture of an EES system is shown in Figure 2. The boundary between the EES system and the electrical power system is defined as POC. Each parameter that is defined in this document shall be measured at POC.

Figure 2 and Figure 3 are examples.

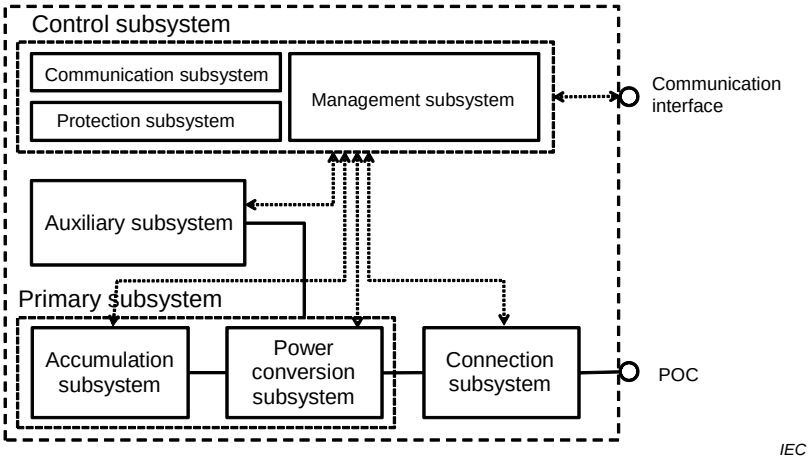

Figure 2 – Typical architecture of EES system

If the auxiliary subsystem is fed from another feeder, the optional architecture of the ESS system is shown in Figure 3.

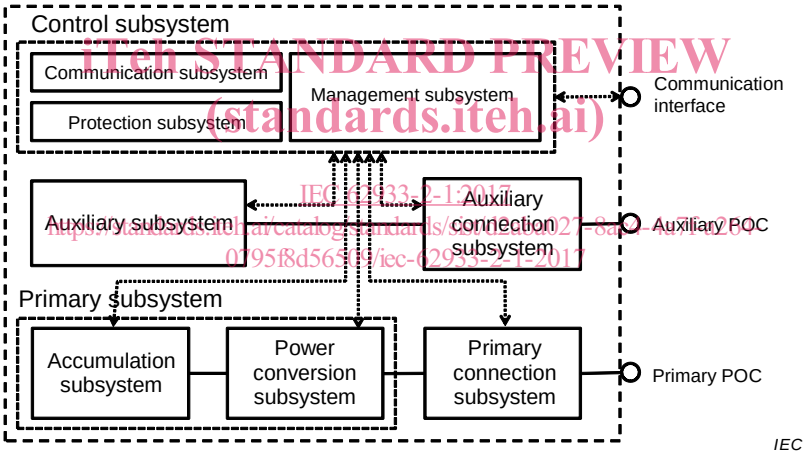

Figure 3 – Optional architecture of EES system

5.2 List of unit parameters

5.2.1 Nominal energy capacity

The nominal energy capacity is the energy that can be output by the system at POC under the standard testing conditions specified in 5.1.3. The energy capacity shall be evaluated considering energy losses including conversion loss and energy used for the auxiliary subsystem. The energy capacity shall be defined as the product of the rated output power and the output duration time at this rated power. The unit of energy capacity shall be defined as Wh for an EES system.

5.2.2 Input and output power rating

5.2.2.1 General

The input and output power is the value of power that an EES system can absorb or provide for a specified time at the POC under the reference environmental conditions specified in 5.1.3. The rated input and output power shall be specified together with input or output duration.

The input and output power are classified as active power *(P)*, reactive power *(Q)* and apparent power *(S)* and the required parameters from these three parameters depending on applications shall be specified. The units of active power, reactive power and apparent power are defined as W, var and VA respectively.

5.2.2.2 Active power

The rated input active power of the EES system is the maximum value of power that can be input at constant for a specified duration at the POC from the lower state of charge limit. Input active power shall be expressed with a negative sign as shown in Figure 4 according to IEC 62933-1 and IEC TR 61850-90-7.

The rated output active power of the EES system is the maximum value of power that can be output for a specified duration at POC from the full available energy level. Output active power shall be expressed with a positive sign as shown in Figure 4 according to IEC 62933-1 and IEC TR 61850-90-7.

The EES system can be applied for various types of applications as listed in Table 1. Different types of input and output characteristics are required for various applications. Therefore, the input power rating, output power rating and input and output period during which the EES system can absorb or deliver constant power should be defined based on the application.

Specific input and output related performance parameters for specific applications may be added as required. Short-duration input and output power is an example. Short-duration input power is the maximum power that the EES system can input at the POC during a specified duration, which is typically less than 5 min. Short-duration output power is the maximum power that the EES system can output at the POC for a specified duration, which is typically less than 5 min. The specific conditions, such as duration for short duration input and output power, shall be specified as agreed upon by the system supplier and user for these specific parameters.

5.2.2.3 Reactive power

The rated reactive power of the EES system is the maximum value of constant reactive power that can be output or input continuously at the POC.

Sign convention of reactive power is shown in Figure 4 according to IEC 62933-1 and IEC TR 61850-90-7.

5.2.2.4 Apparent power

The apparent power is the absolute value of combining active power and reactive power at the POC as shown in Figure 4.