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Edition 1.0 2023-01

TECHNICAL SPECIFICATION

colour inside

Electrical energy storage (EES) systems – Part 3-2: Planning and performance assessment of electrical energy storage systems – Additional requirements for power intensive and renewable energy sources integration related applications



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Electrical energy storage (EES) systems – Part 3-2: Planning and performance assessment of electrical energy storage systems – Additional requirements for power intensive and renewable energy sources integration related applications

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 3-2: Planning and performance assessment of electrical energy storage systems – Additional requirements for power intensive and renewable energy sources integration related applications

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IEC TS 62933-3-2 has been prepared by IEC technical committee 120: Electrical Energy Storage (EES) Systems. It is a Technical Specification.

This Technical Specification is based on IEC TS 62933-3-1:2018 and is to be used in conjunction with IEC TS 62933-3-3:2022.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
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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 Technical Specification 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- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

This part of IEC 62933 should be used as a reference when planning, designing, controlling and operating power intensive and renewable energy sources integration related applications of EES systems.

ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 3-2: Planning and performance assessment of electrical energy storage systems – Additional requirements for power intensive and renewable energy sources integration related applications

1 Scope

This part of IEC 62933 provides the requirements for power intensive and renewable energy sources integration related applications of EES systems, including grid integration, performance indicators, sizing and planning, operation and control, monitoring and maintenance. The power intensive applications of EES systems are usually used to improve the dynamic performance of the grid by discharging or charging based on corresponding control strategies. The renewable energy sources integration related applications of EES systems are usually used to mitigate short-term fluctuation and/or to keep long-term stability. This document includes the following applications of EES systems:

– frequency regulation/support;
– grid voltage support ($Q(U)$) (“volt/var support”);
– voltage sag mitigation;
– renewable energy sources integration related applications;
– power oscillation damping (POD).

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 61850 (all parts), *Communication networks and systems for power utility automation*

IEC TS 62786, *Distributed energy resources connection with the grid*

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

IEC TS 62933-3-1, *Electrical energy storage (EES) systems – Part 3-1: Planning and performance assessment of electrical energy storage systems – General specification*

IEC TS 62933-3-3, *Electrical energy storage (EES) systems – Part 3-3: Planning and performance assessment of electrical energy storage systems – Additional requirements for energy intensive and backup power applications*

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

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

IEC/IEEE 60255-118-1, *Measuring relays and protection equipment – Part 118-1: Synchrophasor for power systems – Measurements*

ISO 5660-1, *Reaction-to-fire tests – Heat release, smoke production and mass loss rate – Part 1: Heat release rate (cone calorimeter method) and smoke production rate (dynamic measurement)*

IEEE C37.118-2015, *IEEE Standard for Synchrophasors for Power Systems*

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 TS 62933-1 and the following apply.

ISO and IEC maintain terminological 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

3.1.1
fast frequency response
fast frequency control
short duration application of an EES system used to slow down the frequency change rate of the electric power system (IEV 601-01-01) during sudden failures and reduce the amplitude of the transient frequency difference, through the capability to actively support grid frequency by discharging or charging very fast (e.g. within 100 ms)

3.1.2
fluctuation reduction
power smoothing
short duration application of an EES system used to reduce power oscillation fluctuation of power generation units (especially renewable energy sources) with regard to their point of connections (IEV 617-04-01) absorbing active power at times of high generation output and by feeding in additional active power at times of low generation output

3.1.3
power oscillation damping
POD
short duration application of an EES system used to restrain power oscillations in one or more connected AC electric power networks (IEV 601-01-02) by active or reactive power flow control

Note 1 to entry: Low frequency power oscillation range is typically from 0,1 Hz to 2 Hz.

3.1.4
primary frequency control
primary frequency regulation
short duration application of an EES system used to stabilize the electric power system (IEV 601-01-01) frequency on a steady state value through the capability to respond to a measured frequency deviation

Note 1 to entry: Generally, the primary frequency control is automatically activated by the primary control system within a few seconds from the measured frequency deviation and fully activated within less than a few minutes.

3.1.5
renewable energy resources generation firming
long duration application of an EES system used to decouple renewable energy source generation and energy consumption for a specific time by absorbing energy in periods with a surplus of energy generation and by provision of energy in periods with a surplus of energy consumption

3.1.6
secondary frequency control
secondary frequency regulation
short duration application of an EES system used to restore system frequency to the nominal system frequency usually following a primary frequency regulation

Note 1 to entry: Generally, the secondary frequency control is manually or automatically activated between 30 s up to 15 min from the primary frequency regulation completion.

3.1.7
self-discharge rate
percentage of the energy loss to full energy capacity of an EES system in the idle period during a predefined measurement time

Note 1 to entry: In the idle period all required peripherals are activated and their energy consumption is therefore counted.

Note 2 to entry: The measurement time is determined rationally according to the self-discharge characteristic of each EES technology.

3.1.8
voltage sag mitigation
voltage dip mitigation
short duration application of an EES system used to compensate the voltage drop during a specified time and for a predefined maximum power, when a voltage sag occurred at the primary POC

Note 1 to entry: The power quality events are described in IEC TS 62749. Voltage dip and voltage sag are frequently used as synonyms.

3.2 Abbreviated terms and symbols

3.2.1 Abbreviated terms

ACE	area control error
AGC	automatic generation control
BAMU	battery array management unit
BCU	battery control unit
BESS	battery energy storage system
BMS	battery management system
BMU	battery management unit
CAES	compressed air energy storage
DER	distributed energy resources
EES	electrical energy storage
EESS	electrical energy storage system
EMC	electromagnetic compatibility
EMS	energy management system
EV	electric vehicle
FAT	factory acceptance test
FES	flywheel energy storage

FFC	flat frequency control
FFR	fast frequency response
FTC	flat tie-line control
HMI	human machine interface
HVAC	heating, ventilation and air conditioning
HVDC	high voltage direct current
LCC	line-commutated converter
MOI	moment of inertia
OFRT	over-frequency ride through
OVRT	over-voltage ride through
PCC	point of common coupling
PCS	power conversion subsystem/power conversion system
PFR	primary frequency response
PMU	phase measurement unit
POC	point of connection
POD	power oscillation damping
PV	photovoltaic
ROCOF	rate of change of frequency
RSDR	reduction in standard deviation of ramp rate
RSDP	reduction in standard deviation of power
SAT	site acceptance test
SCADA	supervisory control and data acquisition
SCR	short-circuit ratio
SFR	secondary frequency response
SMES	superconducting magnetic energy storage
SOC	state of charge
SOH	state of health
SSI	subsynchronous interaction
SSR	subsynchronous resonance
SVC	static var compensator
TBC	tie-line load frequency bias control
UFRT	under-frequency ride through
UVRT	under-voltage ride through

3.2.2 Symbols

P	active power
Q	reactive power
S	apparent power
f	frequency
U	voltage
I	current

4 General planning and performance assessment considerations for EES systems

4.1 Applications of EES systems

4.1.1 Functional purpose of the EES systems

4.1.1.1 General

For the planning of EES systems, it is important to understand the purpose for which the EES systems should be used. It is also conceivable that EES systems can operate on more than just one application. Therefore, the planned applications of the EES systems in the grid to which they are connected should be described.

EES system applications can be distinguished according to various criteria necessary for applications of EES systems:

- demands on energy content;
- demands on active power input and output;
- demands on the frequency of phase transitions during charging and discharging;
- demands on response time and ramp rate performance;
- demands on additional reactive power exchange with the power supply system;
- demands on stand-alone and black-start capabilities.

Besides pure active power and energy applications an EES system can provide a wide range of ancillary services. Subclauses 4.1.1.2 to 4.1.1.5 differentiate between power intensive applications as well as energy intensive and backup power applications.

4.1.1.2 Power intensive applications

EES systems for power intensive applications generally have demands for fast step response performances, for frequent charge and discharge phase transitions or for additional reactive power exchange with the electric power system. Several mature EES technologies, in particular superconducting magnetic energy storage (SMES), supercapacitor, flywheel energy storage (FES) and power type lithium battery, have high power densities but low energy densities, and can be used in these applications. These applications include:

- grid frequency support/regulation;
- grid voltage support;
- power quality support;
- reactive power flow control;
- power oscillation damping (POD).

4.1.1.3 Renewable energy sources integration related applications

By integrating EES systems, various load, energy, power quality and operational management measures can be implemented, which can be used advantageously in combination with renewable energy sources. These applications are:

- power smoothing;
- energy generation firming;
- applications for electric charging stations in combination with renewable energy sources;
- load management (load fluctuation reduction);
- operational management.