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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Railway applications – Fixed installations – Stationary energy storage system for DC traction systems

Applications ferroviaires – Installations fixes – Système stationnaire de stockage d'énergie pour les systèmes de traction en courant continu

IEC 62924:2017-01(en-fr)

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CONTENTS

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RAILWAY APPLICATIONS – FIXED INSTALLATIONS – STATIONARY ENERGY STORAGE SYSTEM FOR DC TRACTION SYSTEMS

FOREWORD

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The text of this standard is based on the following documents:

FDIS	Report on voting
9/2221/FDIS	9/2244/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.

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- withdrawn,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.

INTRODUCTION

To save natural resources and counteract global warming, techniques to save energy and/or to improve environmental characteristics are drawing strong interest. In the railway industry, electric rail vehicles fitted with regenerative braking systems have been introduced, not only to save energy, but also to ease maintenance and to reduce the adverse effects of heat generated during braking (especially in tunnels).

However, in DC electric railways, when a train regenerates power, usually the power has to be consumed within the DC network, because DC power supply substations are usually not reversible. There is no guarantee that adequate load exists for regenerative braking trains; in such a circumstance, regenerative braking becomes ineffective, either in part or in whole. In this situation, the power supply network is unreceptive. Among the emerging technologies to improve receptivity is stationary energy storage systems (ESSs). A stationary ESS charges regenerative energy when the power supply network is unreceptive and stores it for use at a later time.

International Standards for stationary ESSs have not been issued. Before ESSs become widely used, international standardization of the basic system structure and measurement method for efficiency, etc., will serve as a guideline for users and manufacturers who want to introduce ESSs.

RAILWAY APPLICATIONS – FIXED INSTALLATIONS – STATIONARY ENERGY STORAGE SYSTEM FOR DC TRACTION SYSTEMS

1 Scope

This document specifies the requirements and test methods for a stationary energy storage system to be introduced as a trackside installation and used in a power supply network of a DC electrified railway. This system can take electrical energy from the DC power supply network, store the energy, and supply the energy back to the DC power supply network when necessary. This document does not apply to onboard energy storage systems.

This document applies to systems which are installed to achieve one or more of the following objectives.

- Absorption of regenerative energy:
  - effective use of regenerative energy (saving energy);
  - reduction of rolling stock maintenance (reduction of brake shoe/pad wear, etc.);
  - avoidance of adverse effects of heat generated during braking (e.g. in tunnels, etc.).
- Power compensation:
  - compensation of line voltage;
  - reduction of peak power;
  - reduction in the requirement of the rectifier ratings.

If this system is combined with one or more of the following functions, this document may be used as a guideline:

- reverse transmission of regenerated power to the upstream power supply network (e.g. inverting or reversible substations);
- use of the regenerated energy for purposes other than the running of trains, such as for station facilities, etc.;
- resistive consumption of regenerated power.

Although it is assumed that the system uses the following typical energy storage technologies, this document also applies to other existing or future technologies:

- batteries (lithium-ion, nickel metal hydride, etc.);
- capacitors (electric double layer capacitors, lithium-ion capacitors, etc.);
- flywheels.

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 60146 (all parts), *Semiconductor converters*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60850, *Railway applications – Supply voltages of traction systems*

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

IEC 61992-7-1:2006, *Railway applications – Fixed installations – DC switchgear – Part 7-1: Measurement, control and protection devices for specific use in d.c. traction systems – Application guide*

IEC 62236 (all parts), *Railway applications – Electromagnetic compatibility*

IEC 62236-1, *Railway applications – Electromagnetic compatibility – Part 1: General*

IEC 62236-5, *Railway applications – Electromagnetic compatibility – Part 5: Emission and immunity of fixed power supply installations and apparatus*

IEC 62590:2010, *Railway applications – Electronic power converters for substations*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60146 (all parts) 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
energy storage system
ESS
system that can take electrical energy from the DC power supply network, store the energy, and supply the energy back to the DC power supply network when necessary

Note 1 to entry: This note applies to the French language only.

3.1.2
regenerative braking
electro-dynamic braking in which the energy produced by the motors is fed into the contact line or into energy storage on-board devices

Note 1 to entry: Examples of storage devices: batteries, flywheels, etc.

[SOURCE: IEC 60050-811:—, 811-06-25]

3.1.3
regenerative energy
electric energy that is supplied from railway vehicles to the contact lines when power is generated by regenerative braking

3.1.4
energy storage unit
ESU
device to which electrical energy is charged and from which electrical energy is discharged

Note 1 to entry: This note applies to the French language only.

3.1.5
electronic power converter
operative unit for electronic power conversion, comprising one or more electronic valve devices, transformers and filters if necessary and auxiliaries if any

[SOURCE: IEC 60050-551:1998, 551-12-01]

3.1.6
charge-discharge characteristics
characteristics given to the controller of the ESS so that the energy management of the ESS is properly performed under the required duty cycle

3.1.7
duty cycle
time pattern of power supplied to or returned from the electronic power converter or the ESU

3.1.8
short-time withstand current capability
capability to deliver current for a specified short period of time under specified usage and operating conditions

3.1.9
charge-discharge efficiency
<ESS> ratio of discharge energy to charge energy of an ESS through its electrical terminals

Note 1 to entry: The efficiency is calculated using the equation described in 7.1.4.

3.1.10
type test
conformity test made on one or more items representative of the production

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

3.1.11
routine test
conformity test made on each individual item during or after manufacture

[SOURCE: IEC 60050-151:2001, 151-16-17]

3.1.12
commissioning test
test on an item carried out on site, to prove that it is correctly installed and can operate correctly

[SOURCE: IEC 60050-151:2001, 151-16-24]

3.1.13
system charge current
current flowing from the power supply network to the ESS

3.1.14
system discharge current
current flowing from the ESS to the power supply network

3.1.15
system charge power
power flowing from the power supply network to the ESS

3.1.16
system discharge power
power flowing from the ESS to the power supply network

3.1.17
end of life
EOL
point at which the ESU cannot fulfil the required functionality or duty cycle as initially agreed between the user and the manufacturer

Note 1 to entry: This note applies to the French language only.

3.1.18
capacity
electrical charge that can be delivered from the ESU

Note 1 to entry: In case of a battery, the electrical charge is often expressed in ampere-hours (Ah).

Note 2 to entry: In case of a capacitor, the electrical charge is often expressed in coulomb (C).

Note 3 to entry: Capacitance is measured in farad (F), which is charge (C) divided by voltage (V), and is different from capacity.

3.1.19
theoretical capacity
maximum capacity available without loss

[SOURCE: IEC 62864-1:2016, 3.1.17.2]

3.1.20
rated capacity
available capacity measured according to the "rating" conditions as expressed in the relevant standard

Note 1 to entry: Refer to IEC 62928.

[SOURCE: IEC 62864-1:2016, 3.1.17.3]

3.1.21
usable capacity
capacity available to be discharged depending upon applications

[SOURCE: IEC 62864-1:2016, 3.1.17.4]

3.1.22
theoretical energy
maximum energy available without loss stored in the ESU

[SOURCE: IEC 62864-1:2016, 3.1.18.1]

3.1.23
rated energy
energy available measured according to the "rating" conditions as expressed in the relevant standard

Note 1 to entry: Practical definitions of rated energy are dependent upon chosen technologies.

[SOURCE: IEC 62864-1:2016, 3.1.18.2]

3.1.24
usable energy
energy available to be discharged depending upon applications

[SOURCE: IEC 62864-1:2016, 3.1.18.3]

3.1.25
state of charge
SOC
remaining capacity to be discharged, normally expressed as a percentage of full capacity as expressed in relevant standards

Note 1 to entry: Practical definitions of SOC are dependent upon chosen technologies. SOC is applicable to batteries.

Note 2 to entry: For detailed description, see Annex B.

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

[SOURCE: IEC 62864-1:2016, 3.1.13, modified – Note 1 to entry was modified and Notes 2 and 3 to entry were added.]

3.1.26
state of energy
SOE
remaining energy to be discharged, normally expressed as a percentage of full energy as expressed in relevant standards

Note 1 to entry: Practical definitions of SOE are dependent upon chosen technologies. SOE is applicable to all storage technologies.

Note 2 to entry: For detailed description, see Annex B.

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

[SOURCE: IEC 62864-1:2016, 3.1.14, modified – Note 1 to entry was modified and Notes 2 and 3 to entry were added.]

3.1.27
charge energy
<ESS> energy supplied to the ESS through its electrical terminals

3.1.28
discharge energy
<ESS> energy returned from the ESS through its electrical terminals

3.1.29
rate of energy exchange
<ESS> maximum energy that can be charged into or discharged from the ESS during a defined time period under rating conditions

3.1.30
self-discharge
reduction of charge or energy of an ESU that occurs in a period of time during which no energy is either charged into or discharged from the ESU

3.1.31
stand-by losses
losses of an ESS that occur when no power is either charged into or discharged from the ESS under its operation

3.1.32
per unit
p.u.
methodology used to simplify equations and the presentation of electrical parameters by expressing them as a fraction of a reference parameter:

$$\text{p.u.value} = \left(\frac{\text{actual}}{\text{base}} \right)$$

where the actual and base values are of the same quantity, e.g. voltage, current, impedance, etc.

[SOURCE: IEC TR 61000-2-14:2006, 3.13]

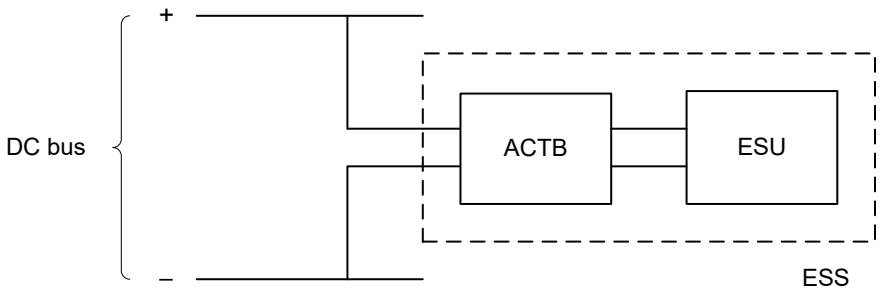
3.2 Abbreviations

ATO automatic train operation
ATP automatic train protection
BOL beginning of life
DCCB DC circuit breaker
EDLC electric double-layer capacitor
EOL end of life
ESU energy storage unit
ESS energy storage system
IP international protection (against ingress) / ingress protection
SOC state of charge
SOE state of energy

4 Configuration of stationary energy storage systems

4.1 General

The stationary energy storage systems to which this document is applicable shall have the common system configuration shown in Figure 1.



ACTB: Apparatus for Connecting the ESU To the DC Bus

IEC

Figure 1 – Common system configuration of stationary ESS

In Figure 1, ESU may be of any available storage technology, such as batteries (lithium-ion, nickel metal hydride, etc.), capacitors (electric double layer capacitors, lithium-ion capacitors, etc.) or flywheels. Also, in Figure 1, there may be a wide variety of the detailed configuration marked as ACTB (apparatus for connecting the ESU to the DC bus).