IEC TS 63346-2-2

Edition 1.0 2026-07

TECHNICAL SPECIFICATION

Low-voltage auxiliary power systems -
Part 2-2: Design criteria - Low-voltage DC auxiliary power systems for substations

ICS 29.240.01; 29.240.30

ISBN 978-2-8327-1377-8

IEC TS 63346-2-2:2026-07(en)

IEC Secretariat
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 corrigendum or an amendment might have been published.

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 It also gives information on projects, replaced and withdrawn publications.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

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 Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

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

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

Low-voltage auxiliary power systems - Part 2-2: Design criteria - Low-voltage DC auxiliary power systems for substations

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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TS 63346-2-2 has been prepared by IEC project committee 127: Low-voltage auxiliary power systems for electric power stations and substations. It is a Technical Specification.

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

Draft	Report on voting
127/86/DTS	127/89/RVDTS

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 63346 series, published under the general title *Low-voltage auxiliary power 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, or
– revised.

1 Scope

This part of IEC TS 63346 provides common rules and specific requirements for the design of low voltage DC auxiliary power systems (APSs) intended to be installed in substations, mainly covering the configuration of DC power sources, system wiring, electric equipment selection and physical layout.

For the purpose of interpreting this document, a DC APS in this document is considered as follows.

– Its scope covers from the low voltage AC input of the charger to the DC input points of loads. Though DC load is discussed where necessary, the load itself is beyond the scope of this document.
– Unless particularly stated, DC APS refers to the system using lead-acid and nickel-cadmium cells which are connected in series. The system using parallel cells can implement this document by reference.

Substations in this document refer to those which are part of an electrical system and contain equipment that either receives and distributes electrical energy or transforms voltages to the levels required by the loads they supply, or both.

This document does not apply to the design of any of the following:

– traction substation, which have different power supply requirements, such as unbalanced load power supply and harmonic behaviour;
– offshore substations, as factors such as waves, typhoons, salt spray, etc. need to be taken into account, which have different requirements for power supply and equipment selection;
– the substation connecting a nuclear power plant to the grid and its associated LV APS integrated with the nuclear power plant.

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 60038, *IEC standard voltages*

IEC 60287 (all parts), *Electric cables - Calculation of the current rating*

IEC 60364-1, *Low-voltage electrical installations - Part 1: Fundamental principles, assessment of general characteristics, and definitions*

IEC 60364-4-41, *Low-voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock*

IEC 60364-4-42, *Low-voltage electrical installations - Part 4-42: Protection for safety - Protection against thermal effects*

IEC 60364-4-43, *Low-voltage electrical installations - Part 4-43: Protection for safety - Protection against overcurrent*

IEC 60364-4-44, *Low-voltage electrical installations - Part 4-44: Protection for safety - Protection against voltage disturbances and electromagnetic disturbances*

IEC 60364-5-51, *Electrical installations of buildings - Part 5-51: Selection and erection of electrical equipment - Common rules*

IEC 60364-5-52, *Low-voltage electrical installations - Part 5-52: Selection and erection of electrical equipment - Wiring systems*

IEC 60623, *Secondary cells and batteries containing alkaline or other non-acid electrolytes - Vented nickel-cadmium prismatic rechargeable single cells*

IEC 60664-1:2020, *Insulation coordination for equipment within low-voltage supply systems - Part 1: Principles, requirements and tests*

IEC 60896-11, *Stationary lead-acid batteries - Part 11: Vented types - General requirements and methods of tests*

IEC 60896-22, *Stationary lead-acid batteries - Part 22: Valve regulated types - Requirements*

IEC 60898-3, *Electrical accessories - Circuit-breakers for overcurrent protection for household and similar installations - Part 3: Circuit-breakers for DC operation*

IEC 60947-2, *Low-voltage switchgear and controlgear - Part 2: Circuit-breakers*

IEC 61056-1, *General purpose lead-acid batteries (valve-regulated types) - Part 1: General requirements, functional characteristics - Methods of test*

IEC 61439-1:2020, *Low-voltage switchgear and controlgear assemblies - Part 1: General rules*

IEC 61439-2, *Low-voltage switchgear and controlgear assemblies - Part 2: Power switchgear and controlgear assemblies*

IEC TR 62060:2001, *Secondary cells and batteries - Monitoring of lead acid stationary batteries - User guide*

IEC 62259, *Secondary cells and batteries containing alkaline or other non-acid electrolytes - Nickel-cadmium prismatic secondary single cells with partial gas recombination*

IEC 62485-2, *Safety requirements for secondary batteries and battery installations - Part 2: Stationary batteries*

IEC TS 63346-1-1, *Low-voltage auxiliary power systems - Part 1-1: Terminology*

IEC 63346-2-1, *Low-voltage auxiliary power systems - Part 2-1: Design criteria - General requirements*[1]

[1] Under preparation. Stage at the time of publication: IEC TS/BPUB 63346-2-1:2025.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purpose of this document, the terms and definitions given in IEC TS 63346-1-1 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
capacity
<for cells or batteries> electric charge which a cell or battery can deliver under specified discharge conditions

Note 1 to entry: The SI unit for electric charge is the coulomb (1 C = 1 A·s) but in practice, capacity is usually expressed in ampere hours (A·h).

[SOURCE: IEC 60050-482:2020, 482-03-14]

3.1.2
ambient temperature
<for electrical installations> temperature of the air or other medium within the proximity of an electrical installation

[SOURCE: IEC 60050-826:2022, 826-10-03]

3.1.3
isolated system
IT-system
system in which no live part is intentionally earthed, except for high impedance connections for protection or measurement purposes

[SOURCE: IEC 60050-195:2021, 195-04-07, modified - The second term "IT-system" has been added.]

3.1.4
meshed network
arrangement of electric conductor and boards forming a combination of star and loop circuits

3.2 Abbreviated terms

AC	alternating current
APS	auxiliary power system
CB	circuit breaker
DC	direct current
HV	high voltage
IFLS	insulation fault location system
IMD	insulation monitoring device
IT	isolated terra
LV	low voltage
Ni-Cd	nickel-cadmium

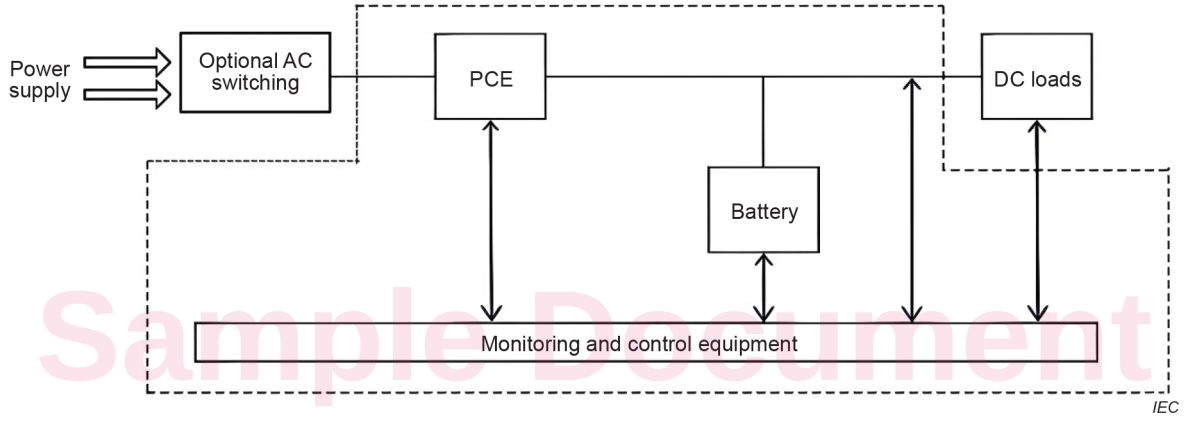
PCE power charger equipment
PE polyethylene
PVC polyvinyl chloride
UPS uninterruptible power system
VRLA valve regulated lead-acid battery

4 General requirements

4.1 General

4.1.1 System typical configuration

A DC APS typically consists of a battery, charger, distribution network, monitoring equipment and control devices as shown in Figure 1.



Key

PCE power charger equipment

Figure 1 – Schematic diagram of a DC APS

During normal operation, chargers convert AC to DC to supply DC loads and maintain the battery on float charge. In case of AC system failure, the battery remains connected to the DC bus, supplying loads for a specified duration until AC power is restored.

This document delineates the DC APS into two segments: the main section from the AC input of the charger to the DC bus, and the distribution network from the DC bus to the load, with details outlined in Clause 6.

4.1.2 Design principles

This document identifies DC APS with different classes of reliability requirements by considering aspects such as adequacy, redundancy and safety from which the station owners, designers and other interested parties can select their best-practice system.

The following principles should be followed in the design of a DC APS.

a) A comprehensive consideration of economy, reliability, flexibility and safety based on a thorough understanding of the specific requirements of project construction, system operation and maintenance.

b) The determination of the system capacity, the selection of the system voltage, the system structure, the protection configuration, the selection and arrangement of the equipment, etc., which should all be based on the characteristics of the primary system. The DC APS design should avoid the common point of failure which can lead to a total power outage of the substation.

c) Fulfillment of quality of supply requirements.

d) Determination of battery autonomy or standby time based on specific circumstance.

NOTE The substation can be subject to standards and regulations in the country where it is located.

The factors that influence the determination of battery autonomy or standby time include the following.

– The importance of the site or equipment from a network management perspective.

– The position of the site on the network re-energisation time schedule. Sites that are closer to the black start origin will be re-energised earlier than sites that are located further away.

– The distance of the site from the nearest technical service centre.

– The accessibility of the site. Sites that are close to national highways and have normal road access are easier and faster to reach compared to sites that are in rural areas, where an off-road vehicle is required or access is necessary.

– The availability of spares. Is it readily available or needs to be sourced from a central location that could take several hours.

– The accessibility of the site to the electricity network (grid-connected). Sites that are not connected to the grid and rely on renewable energy sources (wind or solar) require much longer standby times due to the variability of the energy source.

– The reliability, capacity, availability and flexibility of the AC input power sources, for example, diesel generators.

If the substation has a load centre (for example, series compensation equipment area, controllable high-resistance reactor area, SVG area), and this area is located far from the other DC loads making it difficult to meet cable voltage drop requirements, a separate dedicated DC APS may be set up.

Electric power supply for telecommunication systems in the substation shall be considered when designing DC APS. The power supply system for telecommunication systems may be configured independently or integrated with the DC APS in the substation, depending on the importance of the substation.

If integrated with the DC APS, one or more independent DC/DC converters may be configured to supply power to the telecommunication systems.

4.2 Electrical requirements

4.2.1 Design considerations

The system structure of a DC APS can vary depending on the specific substations, which is discussed in Clause 6. When selecting a system structure, it is important to consider the following aspects:

– operating scenarios;

– redundancy requirements;

– protection philosophies;

– reliability requirements;

– system flexibility requirements;

– electrical filtering requirements;

– physical distance between DC loads and DC APS.

4.2.2 System earthing

The system earthing of DC APS shall comply with IEC 60364-1.

For the continuity of supply, a DC APS shall be designed as an isolated system, also known as a DC IT-system. The main characteristics of an isolated system include the following:

– The output of the system is electrically separated from the AC input.
– The output of the system is electrically separated from the frames and shells of the equipment.
– There is no intentional grounding of any live parts of the system, except for high impedance connections used for measurement purposes.
– Circuit disconnection is not required during single fault conditions.

NOTE The requirements for IT systems are specified in IEC 60364-4-41.

4.2.3 System voltage

The nominal voltage and the maximum operating voltage of the system shall be agreed upon by the users and manufacturers.

The choice of nominal voltage shall consider the following factors:

– legacy systems or relevant industry requirements;
– load profile and distribution area;
– local standard design practices.

NOTE Local regulations can apply.

The typical nominal voltages for DC APSs in substations shall comply with IEC 60038 mainly including 220 V and 110 V.

The operating voltage of the DC APS depends on the load and battery operating voltage windows.

The minimum system voltage shall meet the minimum operating voltage requirements of the connected loads.

4.2.4 Overvoltage protection and insulation coordination

The insulation coordination of the system shall be designed in accordance with IEC 60664-1:2020. The selection of electric insulation technical characteristics for APS equipment shall be based on its applications, surroundings and environmental conditions.

Clearances shall be dimensioned in compliance with IEC 60664-1:2020, 5.2.

Creepage shall be dimensioned in compliance with IEC 60664-1:2020, 5.3.

Solid insulation shall be designed in compliance with IEC 60664-1:2020, 5.4.

4.2.5 Requirements of AC source

To reduce the risk of power loss in the DC APS, two independent AC input power sources can be provided for the charger. The two AC input power sources can be switched manually or automatically.