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Low-voltage switchgear and controlgear assemblies -
Part 8: Assemblies for use in photovoltaic installations

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Low-voltage switchgear and controlgear assemblies - Part 8: Assemblies for use in photovoltaic installations

FOREWORD

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IEC 61439-8 has been prepared by subcommittee 121B: Low-voltage switchgear and controlgear assemblies, of IEC technical committee 121: Switchgear and controlgear and their assemblies for low voltage. It is an International Standard.

This first edition will replace Annex DD, Annex EE and Annex FF from IEC 61439-2 edition 3 published in 2020 to create IEC 61439-8 as a standalone document. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous Annex DD in IEC 61439-2:2020:

a) the scope has been modified to further define the characteristics of PVA;
b) addition of several definitions of different type of boxes and other technical terms;
c) consideration of IP code according to the different applications of PVA;

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

Draft	Report on voting
121B/224/FDIS	121B/227/RVD

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 International Standard 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 of the IEC 61439 series, under the general title *Low-voltage switchgear and controlgear assemblies* can be found on the IEC website.

This document is to be read in conjunction with IEC 61439-1:2020. The provisions of the general rules dealt with in IEC 61439-1 are only applicable to this document insofar as they are specifically cited. When this document states "addition", "modification" or "replacement", the relevant text in IEC 61439-1 is to be adapted accordingly.

Subclauses that are numbered with a 101 (102, 103, etc.) suffix are additional to the same subclause in IEC 61439-1.

Tables and figures in this document that are new are numbered starting with 101.

Annexes in this document are lettered AA, BB, etc.

In this document, general terms and definitions are defined in Subclause 3.1.

In this document, the term Photovoltaic Assembly (PVA) is defined in 3.1.101.

NOTE Throughout the IEC 61439 series of standards, the term assembly (see IEC 61439-1:2020, 3.1.1) is used for a low-voltage switchgear and controlgear assembly.

The reader's attention is drawn to the fact that Annex EE lists all the "in-some-country" clauses on differing practices of a less permanent nature relating to the subject of this document.

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.

INTRODUCTION

The photovoltaic technology enables electricity to be produced directly from sunlight, which is a source of renewable energy. Photovoltaic (PV) energy is one of the most promising technologies meeting the pressing need for green renewable energy and is a part of the answer to the challenge of sustainable development. Pushed by sustainable energy policies, extensive country engagement, technology development, and cost reduction, the number of photovoltaic (PV) installations according to IEC 60364-7-712 is increasing rapidly.

PV installations are usually split into two main categories:

– large scale-utility PV installations, where electricity production can be stored or exported to the grid.

– small PV installations, for example rooftop installation, where the produced energy can be consumed locally or exported to the grid.

PV applications have characteristics that require assemblies with specific performance. A typical arrangement of a PV installation is shown in Figure 101. Further examples are provided in Annex FF.

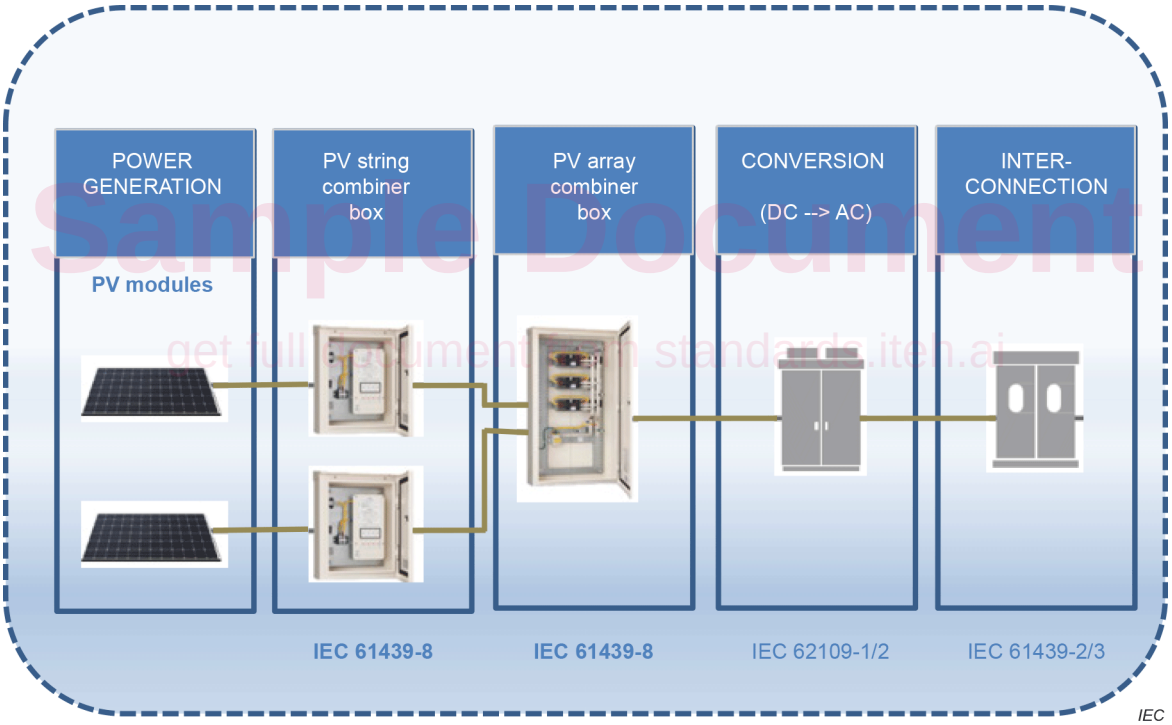

Figure 101 – Example of a large scale-utility PV installation

1 Scope

This part of the IEC 61439 series specifies requirements for the design and verification of low-voltage switchgear and controlgear assemblies for use in photovoltaic installations.

PVAs have the following characteristics:

– assemblies used for the combination of electrical energy in DC systems for which the input and output voltage does not exceed 1 500 V DC;

– assemblies supplied from an AC network where the voltage does not exceed 1 000 V AC for auxiliary and control purposes;

– stationary assemblies with an enclosure;

– assemblies intended for operation by authorised persons (see IEC 61439-1:2020, 3.7.17), but can be located in an area accessible to ordinary persons (see IEC 61439-1:2020, 3.7.16);

– suitable for indoor or outdoor installation.

NOTE 1 PV installations having PV modules with micro-inverters that are connected directly to inter-connection assemblies according to IEC 61439-2 or IEC 61439-3 are not covered by this document.

NOTE 2 Requirements for PVA including other types of DC distribution circuits, for example battery circuits, connected in the same assembly are under consideration.

This document identifies definitions, specifies the service conditions, details the construction requirements, defines the technical characteristics, and provides verifications for PVAs.

PVAs can also include control or signalling devices, or both, associated with the distribution of electrical energy.

This document applies to all PVAs whether they are designed and manufactured on a one-off basis or fully standardized and manufactured in quantity. Either the manufacture or assembly, or both, can be carried out by an entity other than the original manufacturer (see IEC 61439-1:2020, 3.10.1).

This document does not apply to:

– individual devices, for example, circuit-breakers, fuse switches and self-contained components such as, motor starters, switch mode power supplies (SMPS), uninterruptable power supplies (UPS), basic drive modules (BDM), complete drive modules (CDM), adjustable speed power drives systems (PDS), stand-alone energy storage systems (battery and capacitor systems), other electronic equipment which comply with their relevant product standards, such as junction boxes of photovoltaic modules. This document describes their integration into a PVA or an empty enclosure used as a part of a PVA;

– photovoltaic power conversion equipment (PCE) incorporating DC combination sub-systems, covered by the IEC 62109 series.

Some applications, such as either explosive atmospheres or functional safety, or both, can be subject to the requirements of other standards or local installation rules in addition to those specified in the IEC 61439 series.

This document does not apply to the specific types of assemblies covered by other parts of the IEC 61439 series.

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 61439-1:2020, Clause 2, is applicable in addition to the following:

Addition:

IEC 60068-2-14, *Environmental testing - Part 2-14: Tests - Test N: Change of temperature*

IEC 60269-6, *Low-voltage fuses - Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems*

IEC 60364-7-712, *Low voltage electrical installations - Part 7-712: Requirements for special installations or locations - Solar photovoltaic (PV) power supply systems*

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

IEC TR 60890, *A method of temperature-rise verification of low-voltage switchgear and controlgear assemblies by calculation*

IEC 60898-2, *Electrical accessories - Circuit-breakers for overcurrent protection for household and similar installations - Part 2: Circuit-breakers for AC and DC operation*

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

IEC 60947-2:2024, *Low-voltage switchgear and controlgear - Part 2: Circuit-breakers*

IEC 60947-3:2020, *Low-voltage switchgear and controlgear - Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

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

IEC 62109 (all parts), *Safety of power converters for use in photovoltaic power systems*

IEC 62262:2002, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*
IEC 62262:2002/AMD1:2021

IEC 63027, *Photovoltaic power systems - DC arc detection and interruption*

IEC 63112, *Photovoltaic (PV) arrays - Earth fault protection equipment - Safety and safety related functionality*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61439-1 and the following apply.

ISO and IEC maintain terminology 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 General terms

Additional terms and definitions:

3.1.101
photovoltaic assembly
PVA
assembly used in the DC part of a photovoltaic installation to receive electrical energy from one or more PV modules and distributes the energy through one or more outgoing circuits

3.1.102
PV string
circuit of one or more series-connected PV modules

3.1.103
photovoltaic string combiner box
PVA where photovoltaic strings are electrically connected, which can also contain either overcurrent protection or disconnection devices, or both

Note 1 to entry: The terms junction, connection and termination box have the same meaning.

3.1.104
photovoltaic array combiner box
PVA where photovoltaic sub-arrays or arrays are electrically connected, which can also contain either overcurrent protection or disconnection devices, or both

3.1.105
test situation
condition of a PVA or part of it in which the relevant main circuits are open on its supply side but not necessarily isolated whilst the associated auxiliary circuits are connected, allowing operational tests of the incorporated device(s)

3.1.106
form of internal separation
classification of physical separation within a PVA

3.1.107
solar irradiance
irradiance produced by solar radiation expressed in watt per square metre (W/m^2).

3.2 Constructional units of assemblies

Replacement of the title:

3.2 Constructional units of PVAs

Additional terms and definitions:

3.2.101
withdrawable part
removable part intended to be moved from the connected position to the isolated position and to a test position, if any, whilst remaining mechanically attached to the PVA

3.2.102
test position
position of a withdrawable part in which the relevant main circuits are open on its supply side but not necessarily isolated and in which the auxiliary circuits are connected allowing operation tests of the incorporated device(s), the withdrawable part remaining mechanically attached to the PVA

Note 1 to entry: The opening can also be achieved without any mechanical movement of the withdrawable part by operation of a suitable device.

3.2.103
isolated position
position of a withdrawable part in which an isolating distance is established in main and auxiliary circuits on its supply side, the withdrawable part remaining mechanically attached to the PVA

Note 1 to entry: The isolating distance can also be established without any mechanical movement of the withdrawable part by operation of a suitable device, e.g. a disconnector in accordance with IEC 60947-3.

3.2.104
isolating distance

clearance between open contacts of withdrawable parts meeting the safety requirements specified for disconnectors

[SOURCE: IEC 60050-441:2000, 441-17-35, modified – "between open contacts" has been replaced by "between open contacts of withdrawable parts".]

3.4 Structural parts of assemblies

Replacement of the title:

3.4 Structural parts of PVAs

Additional terms and definitions:

3.4.101
active cooling
use of equipment mounted on or within the assembly, installed to reduce or control the assembly's internal air temperature during normal operation, which requires energization to operate

Note 1 to entry: Examples include fans, internal air conditioning, heat exchangers, etc.

3.4.102
pressure relief flap
mechanical component provided to limit the pressure rise in case of internal arc-faults

3.5 Conditions of installation of assemblies

Replacement of the title:

3.5 Conditions of installation of PVAs

3.5.3
stationary assembly

Additional terms and definitions:

3.5.3.701
ground and floor mounted PVA
stationary PVA permanently connected to the supply with a part embedded in the ground or intended to be fixed directly on the floor or a base

3.5.3.702
wall-mounted PVA
stationary PVA intended to be fixed directly on the wall while being permanently fixed to the supply

3.5.101
PVA location with restricted access
location accessible for all persons who are permitted to have access to the location (e.g. private housing, private solar farm or similar places)

3.5.102
PVA location with non-restricted access
location accessible to any person (e.g. the PVA is in an unrestricted area), but the assembly is not intended to be operated by an ordinary person

3.5.103
base
additional part of the arrangement used to support the PVA in any case of mounting intended to accommodate only cables

3.5.104
fixing mean
accessory intended to fix the base or the PVA to the ground, the floor or the wall etc.

3.8 Characteristics

Additional terms and definitions:

3.8.9.2.101
$U_{OC\ MAX}$
maximum voltage across an unloaded (open) PV module, PV string, or PV array, or on the DC side of the PV PCE

3.8.10.7.101
$I_{SC\ MAX}$
maximum short-circuit current produced by a PV module, PV string, Direct Current Unit (DCU) string, PV sub-array or PV array

4 Symbols and abbreviations

IEC 61439-1:2020, Clause 4, is applicable.

5 Interface characteristics

IEC 61439-1:2020, Clause 5, is applicable, except as follows:

5.1 General

Replacement:

The characteristics of the PVA shall ensure compatibility with the ratings of the circuits to which it is connected and the installation conditions. These characteristics shall be declared by the assembly manufacturer using the criteria identified in IEC 61439-1:2020, 5.2 to 5.6, as amended by this document.

The specification schedule detailed in the informative Annex AA is intended to help the user and the assembly manufacturer to meet this objective, whether the user:

– selects catalogue products, the characteristics of which meet their needs, and the requirements of this document; or,
– makes a specific agreement with the assembly manufacturer, or both.

NOTE Annex AA also relates to the topics dealt with in Clause 6 and Clause 7.

5.2 Voltage ratings

5.2.2 Rated operational voltage (U_e) (of a circuit of a PVA)

Addition:

The rated operational voltage (U_e) shall be as minimum $U_{OC\ MAX}$ of the DC circuits of a PVA and shall be specified by the assembly manufacturer.

NOTE See IEC 60364-7-712 for open-circuit maximum voltage ($U_{OC\ MAX}$) for DC circuit of the PVA.

5.3 Current ratings

5.3.1 Rated current of the assembly (I_{nA})

Replacement:

The rated current I_{nA} of the DC part of a PVA is defined by the original manufacturer.

This rated current I_{nA} shall be equal or greater than the sum of short-circuit currents $I_{SC\ MAX}$ of all connected input circuits.

This current shall be carried without the temperature-rise of the individual parts exceeding the limits specified in this document.

Replacement of 5.3.3:

5.3.3 Group rated current of an incoming circuit (I_{ng})

Each incoming circuit of a PVA shall be capable of carrying the maximum short-circuit current $I_{SC\ MAX}$ produced by PV string(s) or PV sub-array continuously. See Figure FF.1 and Figure FF.2 for examples of PV installations.

The maximum short-circuit current $I_{SC\ MAX}$ that can be connected to any incoming circuit shall be specified by assembly manufacturer.

Replacement of 5.3.4:

5.3.4 Maximum short-circuit current ($I_{SC\ MAX}$)

The assembly manufacturer shall declare the value of maximum short-circuit current of all incoming circuits.

NOTE The terms group rated current I_{ng} and maximum short-circuit current $I_{SC\ MAX}$ are considered equal.

5.3.5 Rated short-time withstand current (I_{CW}) (of a main circuit of an assembly)

Addition:

NOTE The selection of the different protection of all incoming circuits are according to the maximum short-circuit current $I_{SC\ MAX}$ of the downstream circuit including the inverter if any (see 60364-7-712).

5.6 Other characteristics

Replacement of item f):

f) degree of protection against contact with hazardous live parts, ingress of solid foreign bodies and water, IP code (see IEC 61439-1:2020, 8.2.2), including the degree of protection for any distinct positions for removable and withdrawable parts;

Replacement of item g):

g) intended for use by (electrically) skilled, competent or instructed persons (see IEC 61439-1:2020, 3.7.13, 3.7.14, and 3.7.15);

Replacement of item l):

l) type of construction, fixed, removable or withdrawable parts (see IEC 61439-1:2020, 8.5.1 and 8.5.2);

Addition:

aa) form of internal separation and associated degree(s) of protection, IP code (see 8.2.2);

bb) mounting orientation (horizontal, vertical, etc.) if the assembly can be mounted in different positions from vertical.

Additional item:

q) locations with restricted access or non-restricted access (see 3.5.101 and 3.5.102).

6 Information

IEC 61439-1:2020, Clause 6, is applicable, except as follows:

6.1 Assembly designation marking

Replacement of the title and item g):

6.1 PVA designation marking

g) IEC 61439-8;

Addition:

h) If an incorporated device does not have adequate switching capacity a warning label visible at the time of the operation shall be provided adjacent to the device stating, "Do not operate under load" (see IEC 62790).

i) If a PVA is energized from more than one source it shall carry a warning label indicating that the assembly is energized from more than one source, and that parts inside the assembly can still be live, unless isolated from all sources of supply including all PV circuits.

j) If a PVA is not suitable for exposure to solar radiation, it shall carry a warning label indicating that the assembly cannot be installed in a position where solar radiation can occur.

6.2 Documentation

6.2.2 Instructions for handling, installation, operation and maintenance

Addition:

Where a PVA is intended for indoor installation or outdoors without exposure to direct sunlight it shall include a warning indicating PVA is not suitable for exposure to direct sunlight.

Where a PVA is exposed to direct sunlight, it shall include a warning label indicating operators should be aware that the temperatures of external parts that are exposed to solar radiation can be high, and precautions should be taken if they are to be touched.

NOTE Further background information regarding documentation is given in the IEC 62446 series.

7 Service conditions

IEC 61439-1:2020, Clause 7, is applicable except as follows.

Additional subclause:

7.101 PVA under solar radiation conditions

PVAs shall be suitable for one of the solar radiation conditions given in Table 101.