IEC 61439-8

Edition 1.0 2026-03

INTERNATIONAL STANDARD

EXTENDED VERSION

This full version of IEC 61439-8:2026 includes the content of the references made to IEC 61439-1:2020

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

ICS 29.130.20

ISBN 978-2-8327-1149-1

IEC 61439-8:2026-03 EXV(en)

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2026 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

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 It also gives information on projects, replaced and withdrawn publications.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

FOREWORD 8
INTRODUCTION to IEC 61439-1:2020 11
INTRODUCTION to IEC 61439-8:2026 12
1 Scope 13
2 Normative references 14
3 Terms and definitions 17
3.1 General terms 17
3.2 Constructional units of PVAs 20
3.3 External design of assemblies 22
3.4 Structural parts of PVAs 23
3.5 Conditions of installation of PVAs 24
3.6 Insulation characteristics 25
3.7 Protection against electric shock 28
3.8 Characteristics 32
3.9 Verification 36
3.10 Manufacturer 37
4 Symbols and abbreviations 37
5 Interface characteristics 38
5.1 General 38
5.2 Voltage ratings 38
5.2.1 Rated voltage (U_n) (of the assembly) 38
5.2.2 Rated operational voltage (U_e) (of a circuit of an assembly) 38
5.2.3 Rated insulation voltage (U_i) (of a circuit of an assembly) 39
5.2.4 Rated impulse withstand voltage (U_{imp}) (of the assembly) 39
5.3 Current ratings 39
5.3.1 Rated current of an assembly (I_{nA}) 39
5.3.2 Rated current of a main outgoing circuit (I_{nc}) 39
5.3.3 Group rated current of an incoming circuit (I_{ng}) 39
5.3.4 Maximum short-circuit current ($I_{SC\ MAX}$) 40
5.3.5 Rated short-time withstand current (I_{cw}) (of a main circuit of an assembly) 40
5.3.6 Rated conditional short-circuit current (I_{cc}) (of an assembly or a circuit of an assembly) 40
5.4 Rated diversity factor (RDF) 40
5.5 Rated frequency (f_n) 41
5.6 Other characteristics 41
6 Information 41
6.1 PVA designation marking 41
6.2 Documentation 42
6.2.1 Information relating to the assembly 42
6.2.2 Instructions for handling, installation, operation and maintenance 42
6.3 Device and/or component identification 43
7 Service conditions 43
7.1 Normal service conditions 43
7.1.1 Climatic conditions 43
7.1.2 Pollution degree 43

7.2 Special service conditions 44
7.3 Conditions during transport, storage and installation 44
7.101 PVA under solar radiation conditions 44
8 Constructional requirements 45
8.1 Strength of materials and parts 45
8.1.1 General 45
8.1.2 Protection against corrosion 46
8.1.3 Properties of insulating materials 46
8.1.4 Resistance to ultra-violet (UV) radiation 46
8.1.5 Mechanical strength 46
8.1.6 Lifting provision 47
8.2 Degree of protection provided by PVA enclosure 47
8.2.1 Protection against mechanical impact (IK code) 47
8.2.2 Protection against contact with live parts, ingress of solid foreign bodies and water (IP code) 47
8.2.101 PVA with withdrawable parts 48
8.2.3 Assembly with removable parts 48
8.3 Clearances and creepage distances 48
8.3.1 General 48
8.3.2 Clearances 49
8.3.3 Creepage distances 49
8.4 Protection against electric shock 49
8.4.1 General 49
8.4.2 Basic protection 50
8.4.3 Fault protection 51
8.4.4 Additional requirements for class II assemblies 54
8.4.5 Limitation of steady-state touch currents and charge 54
8.4.6 Operating and servicing conditions 55
8.5 Incorporation of switching devices and components 56
8.5.1 Fixed parts 56
8.5.2 Removable and withdrawable parts 56
8.5.3 Selection of switching devices and components 57
8.5.4 Installation of switching devices and components 58
8.5.5 Accessibility 58
8.5.6 Barriers 58
8.5.7 Direction of operation and indication of switching positions 59
8.5.8 Indicator lights and push-buttons 59
8.5.9 Power factor correction banks 59
8.6 Internal electrical circuits and connections 59
8.6.1 Main circuits 59
8.6.2 Auxiliary circuits 60
8.6.3 Bare and insulated conductors 60
8.6.4 Selection and installation of non-protected live conductors to reduce the possibility of short-circuits 61
8.6.5 Identification of the conductors of main and auxiliary circuits 61
8.6.6 Identification of the protective conductor (PE, PEL, PEM, PEN) and of the neutral conductor (N) and the mid-point conductor (M) of the main circuits 61
8.6.7 Conductors in AC circuits passing through ferromagnetic enclosures or plates 61

8.7 Cooling 62
8.8 Terminals for external cables 62
8.101 Internal separation of PVA 63
8.102 Thermal cycling durability 64
8.103 Climatic durability 64
9 Performance requirements 64
9.1 Dielectric properties 64
9.1.1 General 64
9.1.2 Power-frequency withstand voltage 64
9.1.3 Impulse withstand voltage 65
9.1.4 Protection of surge protective devices 65
9.2 Temperature-rise limits 65
9.2.1 General 65
9.2.2 Adjustment of rated currents for alternative ambient air temperatures 66
9.3 Short-circuit protection and short-circuit withstand strength 66
9.3.1 General 66
9.3.2 Information concerning short-circuit withstand strength 67
9.3.3 Relationship between peak current and short-time current 67
9.3.4 Coordination of protective devices 67
9.4 Electromagnetic compatibility (EMC) 68
10 Design verification 68
10.1 General 68
10.2 Strength of materials and parts 70
10.2.1 General 70
10.2.2 Resistance to corrosion 70
10.2.3 Properties of insulating materials 72
10.2.4 Resistance to ultraviolet (UV) radiation 73
10.2.5 Lifting 74
10.2.6 Verification of protection against mechanical impact (IK code) 75
10.2.7 Marking 75
10.2.701 Verification of mechanical strength for PVA 75
10.2.8 Mechanical operation 83
10.3 Degree of protection of PVA (IP Code) 83
10.4 Clearances and creepage distances 84
10.5 Protection against electric shock and integrity of protective circuits 84
10.5.1 General 84
10.5.2 Effective earth continuity between the exposed-conductive-parts of the class I assembly and the protective circuit 85
10.5.3 Short-circuit withstand strength of the protective circuit 85
10.6 Incorporation of switching devices and components 86
10.6.1 General 86
10.6.2 Electromagnetic compatibility 86
10.7 Internal electrical circuits and connections 86
10.8 Terminals for external conductors 86
10.9 Dielectric properties 86
10.9.1 General 86
10.9.2 Power-frequency withstand voltage 86
10.9.3 Impulse withstand voltage 88
10.9.4 Testing of enclosures made of insulating material 89

10.9.5 External door or cover mounted operating handles of insulating material 90
10.9.6 Testing of conductors and hazardous live parts covered by insulating material to provide protection against electric shock 90
10.10 Temperature-rise 90
10.10.1 General 90
10.10.2 Verification by testing 91
10.10.3 Verification by comparison 98
10.10.4 Verification assessment 101
10.11 Short-circuit withstand strength 105
10.11.1 General 105
10.11.2 Circuits of assemblies which are exempted from the verification of the short-circuit withstand strength 105
10.11.3 Verification by comparison with a reference design – Using a checklist 106
10.11.4 Verification by comparison with a reference design(s) – Using calculation 106
10.11.5 Verification by test 106
10.12 Electromagnetic compatibility (EMC) 113
10.101 Thermal cycling test 113
10.102 Climatic test 113
11 Routine verification 114
11.1 General 114
11.2 Degree of protection against contact with hazardous live parts, ingress of solid foreign bodies and water of enclosures 114
11.3 Clearances and creepage distances 114
11.4 Protection against electric shock and integrity of protective circuits 115
11.5 Incorporation of built-in components 115
11.6 Internal electrical circuits and connections 115
11.7 Terminals for external conductors 115
11.8 Mechanical operation 115
11.9 Dielectric properties 115
11.10 Wiring, operational performance and function 116
Annex A (normative) Minimum and maximum cross-section of copper cables suitable for connection to terminals for external cables (see 8.8) 129
Annex B (normative) Method of calculating the cross-sectional area of protective conductors with regard to thermal stresses due to currents of short duration 130
Annex C (informative) User information template 131
Annex D (informative) Design verification 132
Annex E (informative) Rated diversity factor 133
E.1 General 133
E.2 Rated diversity factor for outgoing circuits within an assembly 133
E.2.1 General 133
E.2.2 Example of an assembly with an RDF of 0,68 136
E.2.3 Example of an assembly with RDF declared for each section 137
Annex F (normative) Measurement of clearances and creepage distances 138
F.1 Basic principles 138
F.2 Use of ribs 138
Annex G (normative) Correlation between the nominal voltage of the supply system and the rated impulse withstand voltage of the equipment 143
Annex H (informative) Operating current and power loss of copper cables 145

Annex I (informative) Thermal equivalent of an intermittent current 147
Annex J (normative) Electromagnetic compatibility (EMC) 148
J.1 General 148
J.3 Terms and definitions 148
Annex K (normative) Operating current and power loss of bare copper bars 155
Annex L (informative) Guidance on verification of temperature-rise 158
L.1 General 158
L.1.1 Principles 158
L.1.2 Current ratings of assemblies 158
L.2 Temperature-rise limits 159
L.3 Test 160
L.3.1 General 160
L.3.2 Method a) – Verification of the complete assembly (10.10.2.3.5) 160
L.3.3 Method b) – Verification considering individual functional units separately and the complete assembly (10.10.2.3.6) 160
L.3.4 Method c) – Verification considering individual functional units and the main and distribution busbars separately as well as the complete assembly (10.10.2.3.7) 161
L.4 Verification assessment 161
L.4.1 General 161
L.4.2 Single compartment assembly with a rated current (I_{nA}) not exceeding 630 A 161
L.4.3 Assembly with rated currents (I_{nA}) not exceeding 1600 A 161
L.5 Verification by comparison with a reference design 161
Annex M (normative) Verification of the short-circuit withstand strength of busbar structures by comparison with a reference design by calculation 163
M.1 General 163
M.2 Terms and definitions 163
M.3 Method of verification 164
M.4 Conditions for application 165
M.4.1 General 165
M.4.2 Peak short-circuit current 165
M.4.3 Thermal short-circuit strength 165
M.4.4 Busbar supports 165
M.4.5 Busbar connections, equipment connections 165
M.4.6 Angular busbar configurations 165
M.4.7 Calculations with special regard to conductor oscillation 166
Annex N (informative) List of notes concerning certain countries 167
Annex AA (informative) Items subject to agreement between the assembly manufacturer and the user 173
Annex BB (informative) Forms of internal separation (see 8.101) 177
Annex CC (informative) Determining power loss by measurement for circuits exceeding 1 600 A in a reference design 182
CC.1 General 182
CC.2 Method of measurement 182
CC.2.1 General 182
CC.2.2 Power loss measurement for AC circuits 182
CC.2.3 Power loss measurement for DC circuits 183
Annex DD (informative) Design verification (PVA only) 184

Annex EE (informative) List of notes concerning certain countries 186
Annex FF (informative) Examples of PV installations 187
Bibliography 188

Figure 101 – Example of a large scale-utility PV installation 12
Figure 701 – Diagram of test to verify the resistance to static load 77
Figure 702 – Diagram of test to verify the mechanical strength of doors 78
Figure 703 – Sandbag for test to verify the resistance to shock load 79
Figure 704 – Diagram of test to verify resistance to shock load 80
Figure 705 – Diagram of test to verify resistance to torsional stress 82
Figure 706 – Indicative arrangement of radiant heat lamps for temperature-rise test with simulated solar radiation 98
Figure E.1 – Typical assembly 134
Figure E.2 – Example 1: Table E.1 – Functional unit loading for an assembly with a rated diversity factor of 0,68 136
Figure E.3 – Example 2: Table E.1 – Functional unit loading for an assembly with a rated diversity factor of 0,6 in Section B and 0,68 in Section C 137
Figure F.1 – Measurement of clearance and creepage distances 142
Figure I.1 – Example of average heating effect calculation 147
Figure J.1 – Examples of ports 148
Figure L.1 – Verification of temperature-rise 162
Figure M.1 – Tested busbar structure (TS) 163
Figure M.2 – Non tested busbar structure (NTS) 164
Figure M.3 – Angular busbar configuration with supports at the corners 165
Figure BB.1 – Symbols used in Figure BB.2, Figure BB.3 and Figure BB.4 177
Figure BB.2 – Forms 1 and 2 179
Figure BB.3 – Form 3 180
Figure BB.4 – Form 4 181
Figure CC.1 – Power loss measurement of one pole/line 183
Figure FF.1 – PV array combiner box with a single string of modules 187
Figure FF.2 – PV array combiner box with several module strings in parallel 187

Table 101 – Solar radiation conditions 45
Table 1 – Minimum clearances in air (8.3.2) 116
Table 2 – Minimum creepage distances (8.3.3) 117
Table 3 – Cross-sectional area of a copper protective conductor (8.4.3.2.2) 118
Table 4 – Conductor selection and installation requirements (8.6.4) 118
Table 5 – Minimum terminal capacity for copper protective conductors (PE) (8.8) 118
Table 6 – Temperature-rise limits (9.2) 119
Table 7 – Values for the factor n^a (9.3.3) 120
Table 8 – Power-frequency withstand voltage for main circuits (10.9.2) 120
Table 9 – Power-frequency withstand voltage for auxiliary circuits (10.9.2) 120
Table 10 – Impulse withstand test voltages (10.9.3) 120

Table 11 – Copper test conductors for rated currents up to 400 A inclusive (10.10.2.3.2) 121
Table 12 – Copper test conductors for rated currents from 400 A to 7 000 A (10.10.2.3.2) 122
Table 13 – Short-circuit verification by comparison with reference designs: checklist (10.5.3.3, 10.11.3 and 10.11.4) 123
Table 14 – Relationship between prospective fault current and diameter of copper wire 124
Table 15 – Climatic conditions 124
Table 102 – Mechanical tests 125
Table 103 – Test voltages across the open contacts of equipment suitable for isolation 126
Table 104 – Electrical conditions for the different positions of withdrawable parts 127
Table 105 – Forms of internal separation 128
Table A.1 – Cross-section of copper cables suitable for connection to terminals for external cables 129
Table B.1 – Values of k for insulated protective conductors not incorporated in cables or bare protective conductors in contact with cable covering 130
Table D.1 – List of design verifications to be performed 132
Table E.1 – Examples of loading for an assembly 135
Table F.1 – Minimum width of grooves 138
Table G.1 – Correspondence between the nominal voltage of the supply system and the equipment rated impulse withstand voltage 144
Table H.1 – Operating current and power loss of single-core copper cables with a permissible conductor temperature of 70 °C (ambient temperature inside the assembly: 55 °C) 145
Table H.2 – Reduction factor k_1 for cables with a permissible conductor temperature of 70 °C (extract from IEC 60364-5-52:2009, Table B.52.14) 146
Table J.1 – Tests for EMC immunity for environment A (see J.10.12.2) 152
Table J.2 – Tests for EMC immunity for environment B (see J.10.12.2) 153
Table J.3 – Acceptance criteria when electromagnetic disturbances are present 154
Table K.1 – Operating current and power loss of bare copper bars with rectangular cross-section, run horizontally and arranged with their largest face vertical, frequency 50 Hz to 60 Hz (ambient air temperature inside the assembly: 55 °C, temperature of the conductor 70 °C) 155
Table K.2 – Factor k_4 for different temperatures of the air inside the assembly and/or for the conductors 156
Table AA.1 – Items subject to agreement between the assembly manufacturer and the user 173
Table DD.1 – List of design verifications to be performed on PVA 184

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

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

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.

This extended version (EXV) of the official IEC Standard provides the user with the full content of the Standard.

IEC 61439-8:2026 EXV includes the content of IEC 61439-8:2026 and the references made to IEC 61439-1:2020.

The specific content of IEC 61439-8:2026 is displayed on a blue background.

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 to IEC 61439-1:2020

The purpose of this document is to harmonize as far as practicable all rules and requirements of a general nature applicable to low-voltage switchgear and controlgear assemblies, in order to obtain uniformity of requirements and verification for assemblies and to avoid the need for verification in other standards. All those requirements for the various assembly standards which can be considered as general have therefore been gathered in this document together with specific subjects of wide interest and application, e.g. temperature-rise, dielectric properties, etc.

For each type of low-voltage switchgear and controlgear assembly, only two main standards are necessary to determine all requirements and the corresponding methods of verification:

– the basic standard, (this document) referred to as “IEC 61439-1” in the specific standards, covering the various types of low-voltage switchgear and controlgear assemblies;
– the specific assembly standard hereinafter also referred to as the relevant assembly standard.

For a general rule to apply to a specific assembly standard, it should be explicitly referred to by quoting this document followed by the relevant clause or subclause number e.g. “IEC 61439-1:2020, 9.1.3”.

A specific assembly standard may not require, and hence need not call up, a general rule where it is not applicable, or it can add requirements if the general rule is deemed inadequate in the particular case, but it may not deviate from it unless there is substantial technical justification detailed in the specific assembly standard.

Where, in this document, a cross-reference is made to another clause, the reference is to be taken to apply to that clause as amended by the specific assembly standard, where applicable.

Requirements in this document that are subject to agreement between the assembly manufacturer and the user are summarized in Annex C (informative). This schedule also facilitates the supply of information on basic conditions and additional user specifications to enable proper design, application and utilization of the assembly.

For the IEC 61439 series, the following parts are published:

a) IEC 61439-1: General rules
b) IEC 61439-2: Power switchgear and controlgear assemblies (PSC-assemblies)[1]
c) IEC 61439-3: Distribution boards intended to be operated by ordinary persons (DBO)
d) IEC 61439-4: Particular requirements for assemblies for construction sites (ACS)
e) IEC 61439-5: Assemblies for power distribution in public networks
f) IEC 61439-6: Busbar trunking systems (busways)
g) IEC 61439-7: Assemblies for specific applications such as marinas, camping sites, market squares, electric vehicle charging stations
h) IEC TR 61439-0: Guidance to specifying assemblies.

This list is not exhaustive; additional parts can be developed as the need arises.

[1] IEC 61439-2 includes requirements for assemblies for use in photovoltaic installations.

INTRODUCTION to IEC 61439-8:2026

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.

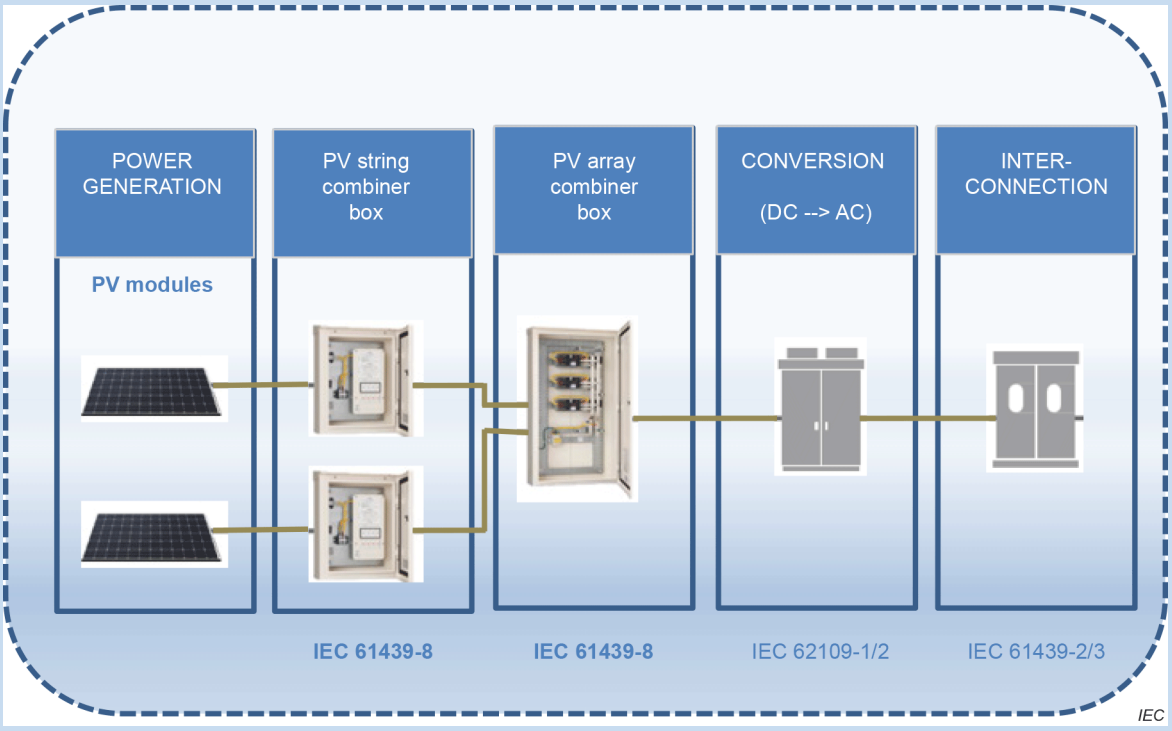


Figure 101 – Example of a large scale-utility PV installation

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 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-11:1981*, Basic environmental testing procedures – Part 2-11: Tests – Test Ka: Salt mist*

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

IEC 60068-2-30:2005, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60073:2002, *Basic and safety principles for man-machine interface, marking and identification – Coding principles for indicators and actuators*

IEC 60085:2007, *Electrical insulation – Thermal evaluation and designation*

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

IEC 60364 (all parts), *Low-voltage electrical installations*

IEC 60364-4-41:2005*, Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*
IEC 60364-4-41:2005/AMD1:2017

IEC 60364-5-51:2005, *Electrical installations of buildings – Part 5-51: Selection and erection of electrical equipment – Common rules*

IEC 60364-5-52:2009, *Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring 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 60439 (all parts), *Low-voltage switchgear and controlgear assemblies*[2]

IEC 60445:2017, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors*

IEC 60447:2004, *Basic and safety principles for man-machine interface, marking and identification – Actuating principles*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*[3]
IEC 60529:1989/AMD1:1999
IEC 60529:1989/AMD2:2013

---

2 Withdrawn. The IEC 60439 series has been cancelled and replaced by the IEC 61439 series.

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

IEC 60695-2-10:2013, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*

IEC 60695-2-11:2014, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products* (GWEPT)

IEC 60695-2-12, *Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials*

IEC 60865-1:2011, *Short-circuit currents – Calculation of effects – Part 1: Definitions and calculation methods*

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 60947-4-1:2018, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio frequency, electromagnetic field immunity test*[4]
IEC 61000-4-3:2006/AMD1:2007
IEC 61000-4-3:2006/AMD2:2010

IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*[5]
IEC 61000-4-5:2014/AMD1:2017

---

3 There is a consolidated document edition 2.2 (2013) that includes IEC 60529 (1989) and its Amendment 1 (1999) and Amendment 2 (2013).

4 There is a consolidated edition 3.2 (2010) that includes IEC 61000-4-3 (2006) and Amendment 1 (2007) and Amendment 2 (2010).

5 There is consolidated edition 3.1 (2017) that includes IEC 61000-4-5 (2014) and its Amendment 1 (2017).

IEC 61000-4-6:2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11:2004, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*
IEC 61000-4-11:2004/AMD1:2017

IEC 61000-6-3:2006, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments*
IEC 61000-6-3:2006/AMD1:2010

IEC 61000-6-4:2018, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*

IEC 61082-1:2014, *Preparation of documents used in electrotechnology – Part 1: Rules*

IEC 61180:2016, *High-voltage test techniques for low-voltage equipment – Definitions, test and procedure requirements, test equipment*

IEC 61439 (all parts), *Low-voltage switchgear and controlgear assemblies*

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

IEC 61921:2017, *Power capacitors – Low-voltage power factor correction banks*

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

IEC 62208:2011, *Empty enclosures for low-voltage switchgear and controlgear assemblies – General requirements*

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*

IEC 81346-1:2009, *Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations – Part 1: Basic rules*

IEC 81346-2:2019, *Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations – Part 2: Classification of objects and codes for classes*

CISPR 11:2015, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*
CISPR 11:2015/AMD1:2016
CISPR 11:2015/AMD2:2019

CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*
CISPR 32:2015/AMD1:2019

ISO 178:2010, *Plastics – Determination of flexural properties*
ISO 178:2010/AMD1:2013

ISO 179-1:2010, *Plastics – Determination of Charpy impact properties – Part 1: Non-instrumented impact test*

ISO 179-2:1997, *Plastics – Determination of Charpy impact properties – Part 2: Instrumented impact test*
ISO 179-2:1997/AMD1:2011

ISO 2409:2013, *Paints and varnishes – Cross-cut test*

ISO 4628-3:2016, *Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 3: Assessment of degree of rusting*

ISO 4892-2:2013, *Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps*

ISO 7010, *Graphical symbols – Safety colours and safety signs – Registered safety signs*

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

3.1.1
low-voltage switchgear and controlgear assembly
assembly
combination of one or more low-voltage switching devices together with associated control, measuring, signalling, protective, regulating equipment, with all the internal electrical and mechanical interconnections and structural parts, as defined by the original manufacturer, which can be assembled in accordance with the original manufacturer's instructions

Note 1 to entry: Throughout this document, the term assembly(s) is used for a low-voltage switchgear and controlgear assembly(s)

Note 2 to entry: The term "switching device" includes mechanical switching devices and semiconductor switching devices, e.g. soft starters, semiconductor relays, frequency converters. The auxiliary circuits may also include electro-mechanical devices, e.g. control relays, terminal blocks, and electronic devices, e.g. electronic motor control devices, electronic measurement and protection devices, bus communication, programmable logic controller systems.

3.1.2
assembly system
full range of mechanical and electrical components (enclosures, busbars, functional units, auxiliary circuits and associated controls, etc.), as defined by the original manufacturer, which