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Interested committees:

Title: BS EN IEC 63409-1 Photovoltaic power generating systems connection with grid - Conformity assessment for power conversion equipment

Part 1: Overall description of conformity assessment for grid connection

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Introduction

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



82/2295/CD

COMMITTEE DRAFT (CD)

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SECRETARIAT:

United States of America

SECRETARY:

Mr George Kelly

OF INTEREST TO THE FOLLOWING COMMITTEES:

TC 8,TC 22,TC 57,TC 69,TC 77,TC 88,ACTAD

HORIZONTAL FUNCTION(S):

ASPECTS CONCERNED:

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TITLE:

Photovoltaic power generating systems connection with grid - Conformity assessment for power conversion equipment - Part 1: Overall description of conformity assessment for grid connection

NOTE FROM TC/SC OFFICERS:

This project was discussed and supported by WG6 during their meeting in 2024-04.

CONTENTS

1	FOREWORD.....	5
2	INTRODUCTION.....	7
3	1 Scope.....	8
4	2 Normative references	8
5	3 Terms and definitions	10
6	4 Requirements for the testing of power conversion equipment	11
7	4.1 General.....	11
8	4.2 Reference points of requirements	12
9	4.3 Elements and configuration.....	12
10	4.3.1 Elements in PV systems	12
11	4.3.2 Configuration of PV systems.....	13
12	4.4 Testing environment	16
13	4.5 Basic operation.....	22
14	4.5.1 Requirements on basic operation.....	22
15	4.5.2 Testing requirements for the evaluation of basic operation	23
16	4.6 Protection and fault ride through function.....	23
17	4.6.1 Requirements on protection and fault ride through function	23
18	4.6.2 Testing requirements for the evaluation of protection and fault ride through function.....	24
19	4.7 Power control and grid support function	24
20	4.7.1 Requirements on power control and grid support function.....	24
21	4.7.2 Testing requirements for the evaluation of power control and grid support function.....	26
22	4.8 Electromagnetic compatibility.....	26
23	4.8.1 Requirements on electromagnetic compatibility	26
24	4.8.2 Testing requirements for the evaluation of electromagnetic compatibility	27
25	4.9 Information exchange for remote monitoring, control and configuration	27
26	4.9.1 Remote monitoring function	27
27	4.9.2 Remote control function.....	29
28	4.9.3 Remote configuration function	30
29	4.9.4 Testing requirements for the remote monitoring, control and configuration function	34
30	Annex A (normative) Application point of requirements for the connection of PV systems with electric power networks	36
31	A.1 Reference points.....	36
32	A.2 Relation between compatibility, immunity, emission, and planning levels	37
33	Annex B (normative) Electromagnetic environment classes and compatibility levels specified in IEC 61000 series	43
34	B.1 Overview	43
35	B.2 Electromagnetic environment classes	43
36	B.3 Compatibility levels for each electromagnetic phenomenon.....	44
37	B.4 Compatibility levels specified in IEC 61000-2-2, IEC 61000-2-4, and IEC 61000-2-12	46
38	Annex C (normative) Sign conventions for measurements of voltage, current and power	47
39	C.1 General.....	47

49	C.2	Reference polarity and direction.....	47
50	C.2.1	Reference polarity of voltage	47
51	C.2.2	Reference direction of current.....	47
52	C.2.3	Sign conventions for measurements of voltage, current and power	48
53	C.3	Reference frame of active and reactive power.....	48
54	C.4	Physical meanings of the power flows of generators in regional standards	52
55	Bibliography.....		54
56			
57	Figure 1 – Possible elements of PV system		13
58	Figure 2 – Configuration of a grid tied PV system consisting of a single generating unit.....		13
59	Figure 3 – Configuration of a grid tied PV system consisting of multiple generating		
60	units		14
61	Figure 4 – Example of parts comprising photovoltaic power generating systems		15
62	Figure 5 – Example of a testing environment		16
63	Figure 6 – Example of the producer reference frame.....		23
64	Figure A.1 – Three reference points where requirements are applied.....		37
65	Figure A.2 – Example of the location of PCC in the public low-voltage network.....		38
66	Figure A.3 – Illustration of EMC concepts		39
67	Figure A.4 – Relation between compatibility, immunity, emission, and planning levels		40
68	Figure A.5 – Autonomous operation of PV systems		41
69	Figure A.6 – Wide and remote area operation of DER and loads with an energy		
70	management system		42
71	Figure C.1 – Reference polarity of voltage		47
72	Figure C.2 – Reference polarity of current.....		47
73	Figure C.3 – Reference polarity and direction for the measurements for DER		48
74	Figure C.4 – Reference polarity and direction for the measurements for Load.....		48
75	Figure C.5 – Rotating vector voltage and current for load		49
76	Figure C.6 – Rotating vector voltage and current for DER		49
77	Figure C.7 – Complex power for load		50
78	Figure C.8 – Complex power for DER		51
79	Figure C.9 – Power quadrants for load.....		51
80	Figure C.10 – Power quadrants for DER		52
81			
82	Table 1 – List of requirements and relevant clauses in Part 1		11
83	Table 2 – Types of PV system with possible elements		12
84	Table 3 – Some of parts comprising of PV systems other than the PCE		15
85	Table 4 – Required functions for power supplies		17
86	Table 5 – Minimum required parameters of specifications for power supplies.....		18
87	Table 6 – Measured electrical quantity with measuring instruments/devices.....		19
88	Table 7 – Minimum required parameters of specifications for measuring		
89	instruments/devices		21
90	Table 8 – Relevant IEC documents on each function		24
91	Table 9 – Existing standards for immunity requirements		26
92	Table 10 – Nameplate data		27
93	Table 11 – Basic information (Those data are not in the nameplate)		28

94	Table 12 – Status of the PV system	28
95	Table 13 – Measured values of the PV system.....	28
96	Table 14 – Minimum required parameters for Connect/Disconnect	29
97	Table 15 – Minimum required parameters for Constant power factor control	29
98	Table 16 – Minimum required parameters for Maximum active power control	29
99	Table 17 – Minimum required parameters for Active power control.....	30
100	Table 18 – Minimum required parameters for Reactive power control.....	30
101	Table 19 – Minimum required parameters for protection and ride-through relevant to	
102	voltage.....	31
103	Table 20 – Minimum required parameters for protection and ride-through relevant to	
104	frequency.....	31
105	Table 21 – Minimum required parameters for Voltage – Var control	31
106	Table 22 – Minimum required parameters for Frequency – Watt control	32
107	Table 23 – Minimum required parameters for Voltage – Watt control.....	33
108	Table 24 – Minimum required parameters for Dynamic-reactive current control.....	33
109	Table B.1 – Classes of electromagnetic environments defined in IEC 61000-2-4.....	43
110	Table B.2 – Total harmonic distortion.....	44
111	Table B.3 – Power supply voltage amplitude variations.....	44
112	Table B.4 – Power supply voltage Unbalance	44
113	Table B.5 – Power supply voltage frequency variations.....	44
114	Table B.6 – Individual Harmonic voltage	45
115	Table B.7 – Compatibility levels specified in IEC 61000-2-2/-4/-12.....	46
116	Table C.1 – Physical meanings of the power flows of loads	52
117	Table C.2 – Physical meanings of the power flows of generators	52
118	Table C.3 – Physical meanings of the power flows of generators in Japan	52
119	Table C.4 – Physical meanings of the power flows of generators in IEEE 1547.1	53
120	Table C.5 – Physical meanings of the power flows of generators in EN 50549-10	53
121	Table C.6 – Physical meanings of the power flows of generators in AS/NZS 4777.2	53
122		
123		

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**PHOTOVOLTAIC POWER GENERATING SYSTEMS CONNECTION WITH
THE GRID
– TESTING OF POWER CONVERSION EQUIPMENT****Part 1: General requirements****FOREWORD**

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Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

176
177 Full information on the voting for its approval can be found in the report on voting indicated in
178 the above table.

179 The language used for the development of this [...International Standard, Technical
180 Specification: specify document type...] is English [change language if necessary].

181 This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in
182 accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, [and the
183 ISO/IEC Directives, JTC 1 Supplement] available at www.iec.ch/members_experts/refdocs. The
184 main document types developed by IEC are described in greater detail at
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187 stability date indicated on the IEC website under webstore.iec.ch in the data related to the
188 specific document. At this date, the document will be

- 189 • reconfirmed,
- 190 • withdrawn,
- 191 • replaced by a revised edition, or
- 192 • amended.

193

INTRODUCTION

In 2017, Ed.1 of IEC TS 62786, which specified general requirements for Distributed Energy Resources (DER) regarding connection with distributed power networks, was published. During the development of Ed.1 of IEC TS 62786, it has been recognised that standardization should address the requirements for the specific types of DER. That was because, in 2016, TC82 proposed to develop a standard on grid connection requirements for solar photovoltaic energy systems on the basis of TS 62786 and to publish it as a sub-part of TS 62786. Consequently, JWG10 was established under TC8 in 2018, and JWG10 held a kick off meeting with TC82 and TC120 in March 2018 and agreed to start the development of the TS 62786 series.

In October 2018, JWG10 proposed a new standardization policy for the TS 62786 series so that the TS 62786 series would have a hierarchical structure. The top layer is the part 1 of the TS 62786 series which specifies general technical requirements for DER relevant to grid connection such as power control and grid protection functions. Additionally, TS 62786-1 specifies new requirements regarding interoperability to implement information exchange for remote monitoring, control and configuration. In October 2021, TC8 CAG agreed the hierarchical structure of TS 62786 series, and it was also agreed that each technical committee can define testing provisions for evaluating the performance of its own product by referring to the TS 62786 series.

In parallel with such a liaison work with TC8, since 2016, TC82 has been preparing the standardization of testing requirements to evaluate the performance and characteristics of power conversion equipment (PCE) for use in solar photovoltaic energy systems (PV systems). While considering contents of a new standard.

TC82 was concerned about a volume of the standard because requirements on the connection of PCE with the distribution power networks includes a lot of aspects, such as protections, power controls, and power quality. Additionally, TC82 recognized that information exchange such as remote monitoring, control, and configuration of PCE should be considered to implement interoperability and configurability of PV systems. Moreover, as the standard for the evaluation of the performance and characteristics of PCE, required specifications of the testing environment need be clarified in order to enhance the reliability and validity of test results and to ensure the reproducibility and repeatability.

Therefore, supplementing IEC TS 62786-1 with additional specific requirements for the connection of PV systems with distribution power systems, this document describes the following requirements on testing of the PCE:

- reference points of requirements,
- elements and configuration,
- testing environments,
- basic operation,
- protection and fault ride through function,
- power control and grid support function,
- electromagnetic compatibility,
- information exchange for remote monitoring, control, and configuration.

PHOTOVOLTAIC POWER GENERATING SYSTEMS CONNECTION WITH THE GRID – TESTING OF POWER CONVERSION EQUIPMENT

Part 1: General requirements

1 Scope

The IEC 63409 series specifies requirements for the testing of power conversion equipment (PCE) for use in photovoltaic power systems (PV systems) with or without DC-coupled electrical energy storage devices. Part 1 of this series provides general requirements for test items which evaluate the performance and characteristics of the PCE in accordance with requirements for the connection of distributed energy resources (DER) with the grid, which are specified in the IEC TS 62786 series. Other parts of IEC 63409 series provide the detailed procedures on testing of the PCE.

Supplementing IEC TS 62786-1 with additional specific requirements for the connection of PV systems with the grid, this document describes the following requirements on testing of the PCE:

- reference points of requirements,
- elements and configuration,
- testing environments,
- basic operation,
- protection and fault ride through function,
- power control and grid support function,
- electromagnetic compatibility,
- information exchange for remote monitoring, control, and configuration.

The PCE covered by this series can be grid-interactive, which is termed as a grid connected power converter (GCPC). The PCE can be supplied by single or multiple photovoltaic modules grouped in various array configurations and can be intended for use in conjunction with batteries or other forms of energy storage.

This series covers not only the PCE connected to a public low voltage AC mains network or other low voltage AC mains installation, but also the PCE connected to a medium voltage AC network with or without external step-down power transformers.

Note: PCE in stand-alone is not covered in this series of standards.

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 62934:2021, *Grid integration of renewable energy generation - Terms and definitions*

IEC TS 62786-1 ED1, *Distributed energy resources connection with the grid – Part 1: General requirements*

- 278 IEC TS 62786-3 ED1, *Distributed energy resources connection with the grid – Part 3 Additional*
279 *requirements for Stationary Battery Energy Storage System*
- 280 IEC 61724-1:2021, *Photovoltaic system performance - Part 1: Monitoring*
- 281 IEC 60255-127:2010, *Measuring relays and protection equipment - Part 127: Functional*
282 *requirements for over/under voltage protection*
- 283 IEC 60255-181:2019, *Measuring relays and protection equipment - Part 181: Functional*
284 *requirements for frequency protection*
- 285 IEC TS 62910:2020, *Utility-interconnected photovoltaic inverters - Test procedure for under*
286 *voltage ride-through measurements*
- 287 IEC TS 63217:2021, *Utility-interconnected photovoltaic inverters - Test procedure for over*
288 *voltage ride-through measurements*
- 289 IEC 61850-7-420:2021, *Communication networks and systems for power utility automation -*
290 *Part 7-420: Basic communication structure - Distributed energy resources and distribution*
291 *automation logical nodes*
- 292 IEC 61850-7-4:2010/AMD1:2020, *Amendment 1 - Communication networks and systems for*
293 *power utility automation - Part 7-4: Basic communication structure - Compatible logical node*
294 *classes and data object classes*
- 295 IEC TS 62786-41:2023, *Distributed energy resources connection with the grid - Part 41:*
296 *Requirements for frequency measurement used to control distributed energy resources (DER)*
297 *and loads*
- 298 IEC 61000-4-13:2002/AMD2:2015, *Amendment 2 - Electromagnetic compatibility (EMC) - Part*
299 *4-13: Testing and measurement techniques - Harmonics and interharmonics including mains*
300 *signalling at a.c. power port, low frequency immunity test*
- 301 IEC 61000-4-11:2020, *Electromagnetic compatibility (EMC) - Part 4-11: Testing and*
302 *measurement techniques - Voltage dips, short interruptions and voltage variations immunity*
303 *tests for equipment with input current up to 16 A per phase*
- 304 IEC 61000-4-34:2005/AMD1:2009, *Amendment 1 - Electromagnetic compatibility (EMC) - Part*
305 *4-34: Testing and measurement techniques - Voltage dips, short interruptions and voltage*
306 *variations immunity tests for equipment with mains current more than 16 A per phase*
- 307 IEC 61000-4-27:2000/AMD1:2009, *Amendment 1 - Electromagnetic compatibility (EMC) - Part*
308 *4-27: Testing and measurement techniques - Unbalance, immunity test for equipment with input*
309 *current not exceeding 16 A per phase*
- 310 IEC 61000-4-19:2014, *Electromagnetic compatibility (EMC) - Part 4-19: Testing and*
311 *measurement techniques - Test for immunity to conducted, differential mode disturbances and*
312 *signalling in the frequency range 2 kHz to 150 kHz at a.c. power ports*
- 313 IEC 61000-4-28:1999/AMD2:2009, *Amendment 2 - Electromagnetic compatibility (EMC) - Part*
314 *4-28: Testing and measurement techniques - Variation of power frequency, immunity test for*
315 *equipment with input current not exceeding 16 A per phase*
- 316 IEC 60050-901:2013, *International Electrotechnical Vocabulary (IEV) - Part 901:*
317 *Standardization*

IEC 61000-2-2:2002/AMD2:2018, *Amendment 2 - Electromagnetic compatibility (EMC) - Environment - Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems*

IEC 61000-2-4:2024, *Electromagnetic compatibility (EMC) - Part 2-4: Environment - Compatibility levels in power distribution systems in industrial locations for low-frequency conducted disturbances*

IEC 61000-2-12:2003, *Electromagnetic compatibility (EMC) - Part 2-12: Environment - Compatibility levels for low-frequency conducted disturbances and signalling in public medium-voltage power supply systems*

IEC 60375:2018, *Conventions concerning electric circuits*

IEC 61557-12:2018/AMD1:2021, *Amendment 1 - Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC - Equipment for testing, measuring or monitoring of protective measures - Part 12: Power metering and monitoring devices (PMD)*

IEC 62053-23:2020, *Electricity metering equipment - Particular requirements - Part 23: Static meters for reactive energy (classes 2 and 3)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62934, IEC TS 62786 series, 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 photovoltaic power generating system PV system

electric power generating system which uses the photovoltaic effect to convert solar power into electricity

3.2 Point of connection POC

reference point on the electric power network where the user's electrical facility is connected

[SOURCE: IEC 60050-617:2009, 617-04-01]

3.3 power conversion equipment PCE

electrical device converting one form of electrical power to another with respect to voltage, current, frequency, phase and the number of phases

[SOURCE: IEC 62109-1:2010, 3.66, modified – The definition has been rephrased, and the note has been deleted.]

3.4**Point of common coupling****PCC**

point in an electric power system, electrically nearest to a particular load or the POC of a power plant, at which other loads/power plants are, or may be, connected

Note 1 to entry: These loads can be either devices, equipment or systems, or distinct customer's installations.

[SOURCE: IEC 62934:2021, 3.1.11]

3.5**In-plant point of coupling****IPC**

point on a network inside a system or an installation, electrically nearest to a particular load, at which other loads are, or could be, connected

NOTE The IPC is usually the point for which electromagnetic compatibility is to be considered.

[SOURCE: IEC 61000-2-4:2002, 3.1.7]

3.6**power distribution systems in industrial locations****industrial power distribution system**

distribution network which is separated by at least one separation transformer from the public power supply system to which other customer installations are connected

3.7**planning level**

a level of a particular disturbance in a particular environment, adopted as a reference value for the limits to be set for the emissions from large loads and installations, in order to co-ordinate those limits with all the limits adopted for equipment intended to be connected to the power supply system

NOTE The planning level is locally specific and is adopted by those responsible for planning and operating the power supply network in the relevant area. For further information, see Annex A of IEC 61000-2-2

[SOURCE: IEC 61000-2-2:2018]

4 Requirements for the testing of power conversion equipment**4.1 General**

Table 1 shows requirements provided with this document and shows relevant clauses of IEC TS 62786-1.

Table 1 – List of requirements and relevant clauses in Part 1

Clause in IEC 63409-1		Relevant clauses in IEC TS 62786-1
4.2	Reference points of requirements	1 Scope and object 4.2 Connection scheme
4.3	Elements and configuration	4.3 Choice of switchgear
4.4	Testing environment	N/A
4.6	Basic operation	N/A
4.6	Protection and fault ride through function	4.4 Normal operating range 4.5 Immunity to disturbances 4.9 Interface protection

4.7	Power control and grid support function	4.7.2 Voltage support by reactive power 4.7 Power response to voltage changes 4.10 Connection and starting to generate electrical power 4.11 Ceasing and reduction of active power on set point
4.8	electromagnetic compatibility	4.8 EMC and power quality
4.9	Information exchange for remote configuration, control and monitoring	4.12 Remote information exchange

4.2 Reference points of requirements

Requirements for the connection of PV systems with the grid shall be applied at the following three reference points:

- Point of common coupling (PCC)
- In-plant point of coupling (IPC)
- Point of connection (POC)

Annex A describes the application of requirements at the three reference points.

Requirements for the testing of the PCE are applied at the AC power ports of the PCE.

4.3 Elements and configuration

4.3.1 Elements in PV systems

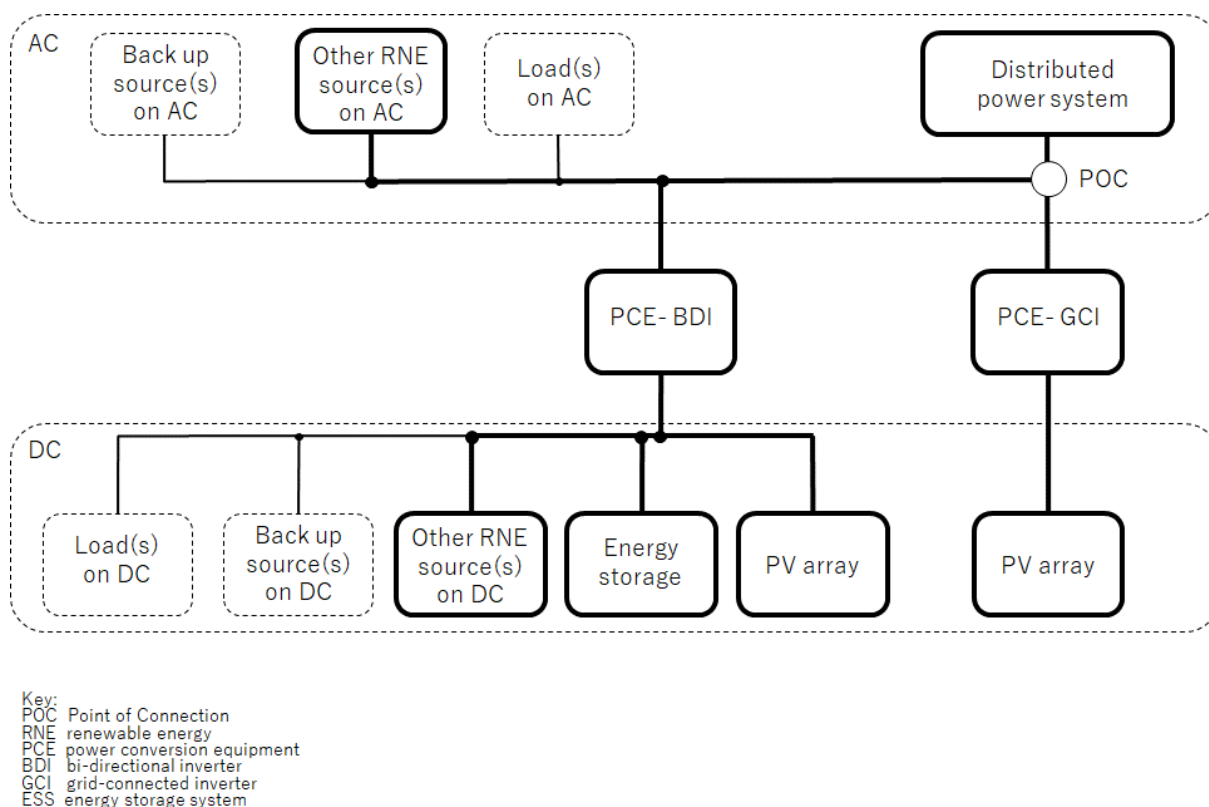
IEC 61724-1 illustrates major possible elements comprising different types of PV systems. Depending on the configuration of PV systems, IEC 61724-1 categorizes PV systems as grid-tied, grid-tied with storage, grid-tied with storage and back-ups, mini-grid or micro-grid. Table 2 shows the types of PV system with possible elements. Figure 1 shows the configuration of PV systems with possible elements.

Requirements for the connection of DER with the grid, which are specified in IEC TS 62786-1, are applied to PV systems which are categorized as grid tied, grid tied with storage and grid tied with storage and back up. Mini-grid and Micro-grid are out of scope.

Table 2 – Types of PV system with possible elements

System element	System type				
	Grid tied	Grid tied with storage	Grid tied with storage and back up	Mini-grid	Micro-grid
PV array (DC)	—	—	—	✓	✓
PV (AC)	✓	✓	✓	✓	✓
Energy storage (DC)	—	✓	✓	✓	✓
PCE-GCI	✓	✓	✓	✓	✓
PCE-BDI	—	✓	✓	✓	✓
Utility grid line	✓	✓	✓	—	✓
Load(s) (DC)	—	—	✓	✓	✓
Load(s) (AC)	—	—	✓	✓	✓

Back-up sources (DC)	—	—	✓	✓	✓
Other RNE sources (DC)	—	✓	—	✓	✓
Back-up sources (AC)	—	—	✓	✓	✓
Other RNE sources (AC)	—	✓	—	✓	✓

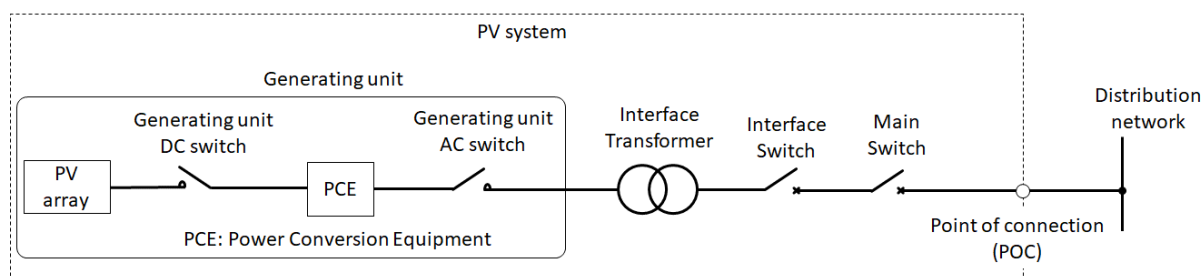


411

412 **Figure 1 – Possible elements of PV system**

413 4.3.2 Configuration of PV systems

414 Figure 2 illustrates an example of the configuration of a grid tied PV system which consists of a
 415 single power generating unit. The main switch should be a circuit breaker with leakage current
 416 protection capability. The interface transformer should be installed in order to avoid the injection
 417 of the DC component to the grid. The generating unit AC switch should be an electromagnetic
 418 or electromechanical contactor. The generating unit DC switch shall be circuit breaker with short
 419 circuit breaking and leakage current protection capability.



421 **Figure 2 – Configuration of a grid tied PV system consisting of a single generating unit**

Figure 3 illustrates an example of the configuration of a grid tied PV system which consists of multiple power generating units. Each generating unit shall have an interface switch, and a single interface switch shall be installed to disconnect all generating units.

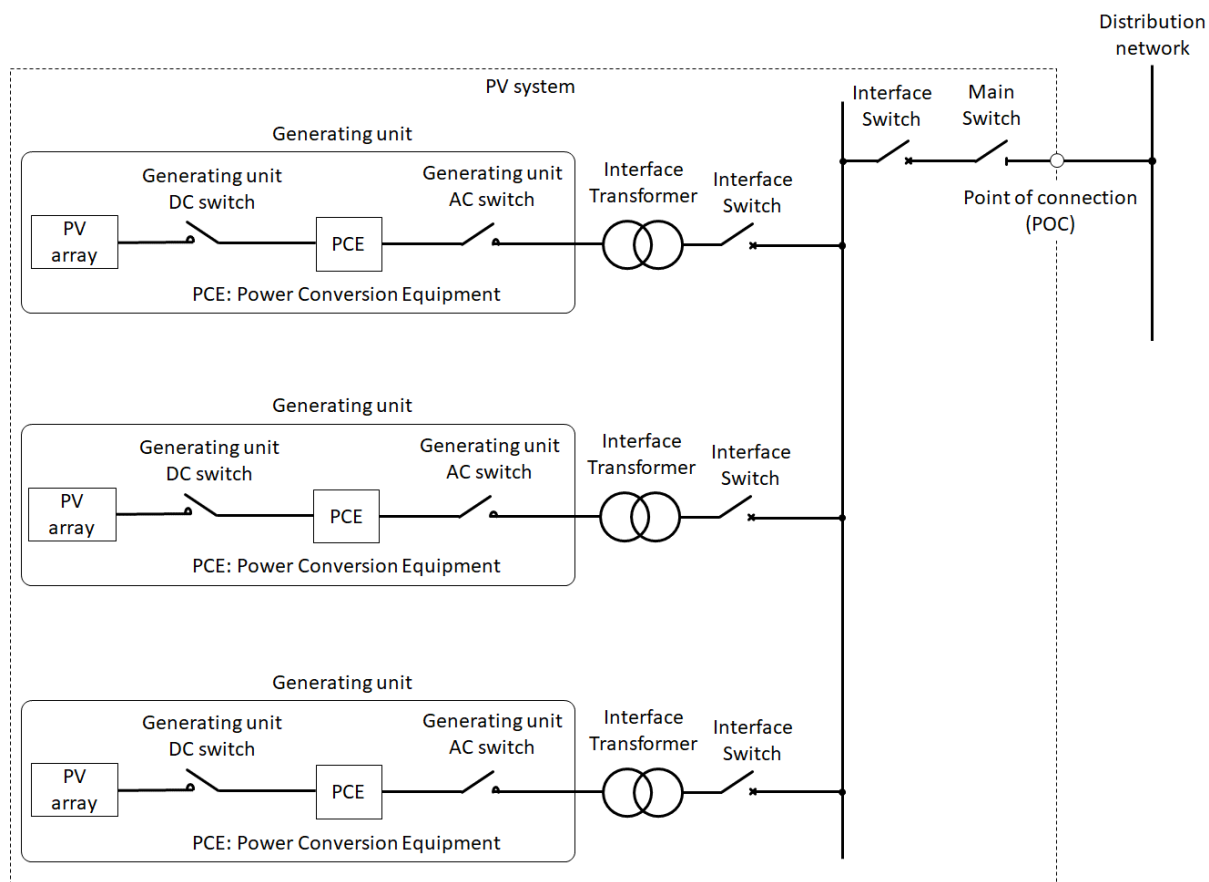


Figure 3 – Configuration of a grid tied PV system consisting of multiple generating units

Figure 4 illustrates an example of parts comprising PV systems, including local loads and controllers. Table 3 lists some of parts comprising of PV systems other than the PCE.

PV systems should be equipped with communication interface for remote monitoring, control and configuration managed by system operators. Specifications and operational status of PV generating unit, the status of all switches and measured values, such as voltage, current and power of PV system should be monitored by the PV system controller, and those of information should be given to system operators with information exchange, if required. Table 3 shows examples of information of switches and sensors to be exchanged with system operators for remote monitoring, control and configuration. Requirements for information exchange of PV systems are given in 4.9.

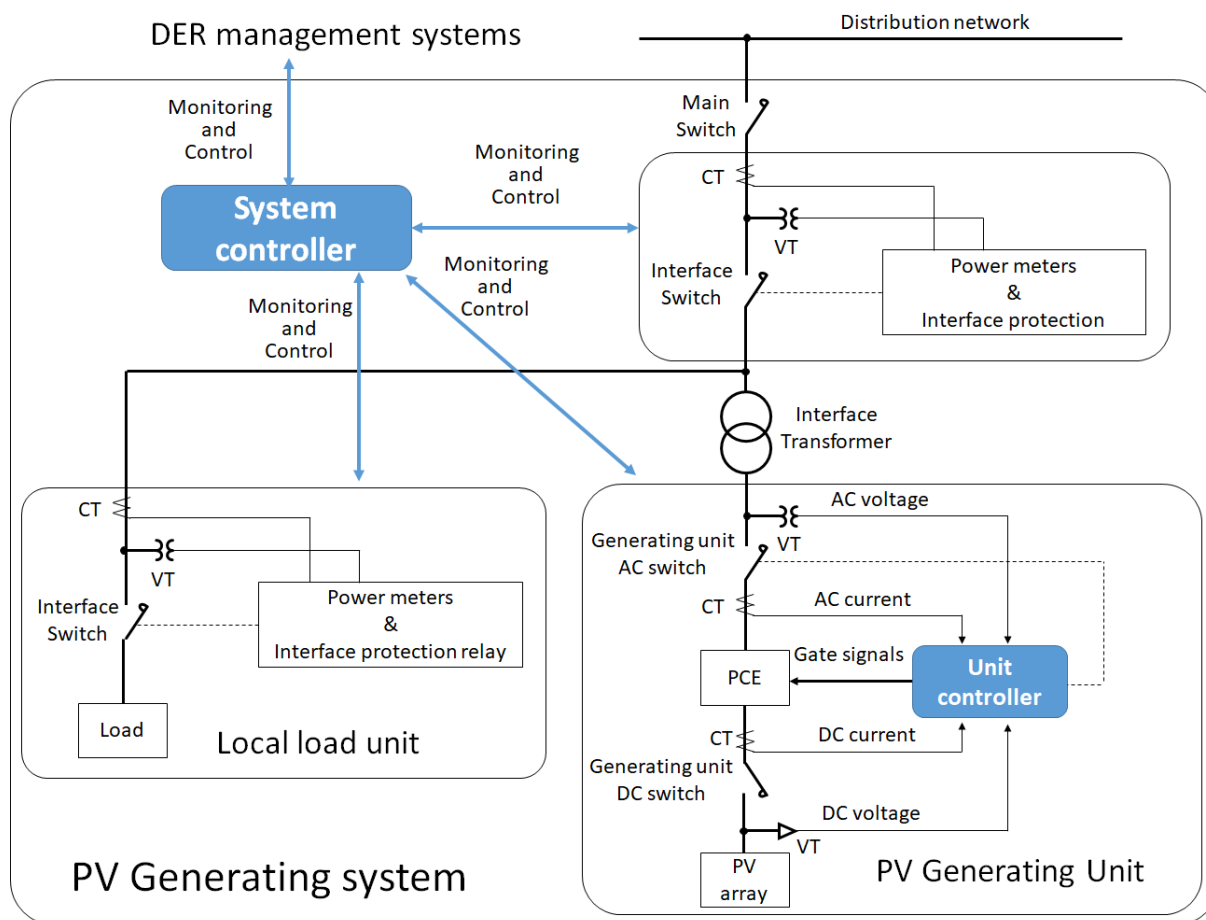


Figure 4 – Example of parts comprising photovoltaic power generating systems

Table 3 – Some of parts comprising of PV systems other than the PCE

Parts comprising PV systems		Information for remote monitoring, control and configuration
Switches	Main switch	Setting information - Installation point - Type of switch (with short circuit breaking capability or not) - Number of phases - Physical capability - Level of short circuit current to be broken Status information - Status of switch - (If circuit breaker) Opening/closing time - Switching operation in local or remote, internally or externally
	Interface switch	
	Generating unit AC switch	
	Generating unit DC switch	
Sensors	Current transformer at main switch	Setting information - Installation point - Rated current - Rated frequency - Ratio between the primary and secondary value
	Current transformer at unit AC switch	