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TECHNICAL SPECIFICATION

Solar photovoltaic energy systems – Terms, definitions and symbols

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SOLAR PHOTOVOLTAIC ENERGY SYSTEMS – TERMS, DEFINITIONS AND SYMBOLS

FOREWORD

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 61836, which is a technical specification, has been prepared IEC technical committee 82: Solar photovoltaic energy systems.

This second edition cancels and replaces the first edition published in 1997. This edition constitutes a technical revision.

This edition included the following significant technical changes with respect to the previous edition:

1) The number of terms has increased. Abbreviations have been included.

2) The terms in Edition 2 are organised into categories and families. Terms contained in families are cross referenced with an alphabetical listing. A bibliography and an index were added. The purpose of aggregating terms into families is to allow readers to easily see the relationships between terms that speak of similar quantities and subjects but that have slight variations.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
82/442/DTS	82/487/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual edition of this document may be issued at a later date.

INTRODUCTION

Following the development of solar photovoltaic (PV) technology, specific Standards have been prepared by IEC Technical Committee 82 since 1987. The terms and symbols used in the PV industry necessitate a systematisation in order to have a consolidated glossary for experts' common understanding.

This Glossary lists the terms and symbols that the PV industry commonly uses. It is a living document that will change as new terms and symbols are added. These have been harmonized with IEC 60050 and other IEC documents as far as possible. All definitions not included in this Technical Specification may be found elsewhere in other IEC documents.

NOTE 1 The terms "PV", "photovoltaic" and "solar photovoltaic" can be read and used interchangeably and without the need for stating each term to show that each are applicable and commonly used by the solar photovoltaic industry.

NOTE 2 All terms beginning with "solar photovoltaic" and "PV" are listed under their respective "photovoltaic" names.

NOTE 3 The terms are listed alphabetically in ten categories. Under these categories, some of the terms have been grouped into families of related meaning in order for the reader to readily see the differences between the terms.

NOTE 4 This Glossary lists the precise usage of terms. Cross-references are provided to efficiently point the reader to the location of definitions. For example, a "solar photovoltaic array" may also be referred to as "photovoltaic array" or "array" when the reference to it is particularly clear. The definition for this term, for example, occurs under the family heading of "photovoltaic" in the "Solar photovoltaic systems" section.

NOTE 5 The colloquial use of "solar" as the sole adjective of a noun is discouraged. For example, though "solar array" may be commonly used in non-technical conversations, the precise terms are "solar photovoltaic array", "photovoltaic array", and "array".

NOTE 6 Unless specifically noted otherwise, the terms "device", "cell", "module", "array", "sub-array", "field", "component", "system", and "product" refer to items incorporating a photovoltaic device. As a result, each of these terms can be understood to read as "PV device", "PV cell", "PV module", *etc.*, without having to re-state the term "PV" each time, though now and then it is useful to re-state "PV".

NOTE 7 The numeric quantities described by many of the terms can be expressed over any convenient unit of time that the user may wish, such as day, month or year.

NOTE 8 "W_p" is <u>not</u> a recommended unit for rated power. For example for a 50 W module, the correct terminology is "the rated power is 50 W", and not "the power is 50 W_p".

NOTE 9 The documents from which these terms originated are shown in square brackets [ ]. Some adaptations may have occurred.

NOTE 10 This Glossary document recognises the related IEC co-ordinating Technical Committees:

1	Terminology	77	Electromagnetic compatibility
21	Secondary cells and batteries	82	Solar photovoltaic energy systems
22	Power electronic systems and equipment	88	Wind turbines
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SOLAR PHOTOVOLTAIC ENERGY SYSTEMS – TERMS, DEFINITIONS AND SYMBOLS

1 Scope and object

This Technical Specification deals with the terms and symbols from national and international solar photovoltaic standards and relevant documents used within the field of solar photovoltaic (PV) energy systems. It includes the terms and symbols compiled from the published IEC technical committee 82 standards, previously published as technical report IEC 61836:1997.

The focus of this Technical Specification is "what do the words mean" and not "under what conditions do the terms apply".

2 Normative references

The following referenced documents are indispensable for the application 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 60904-3:1989, *Photovoltaic devices – Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data*

3 Glossary of terms, definitions and symbols for solar photovoltaic energy systems

3.1 Solar photovoltaic cells and modules

This subclause addresses vocabulary pertaining to photovoltaic materials, photovoltaic cells and photovoltaic modules. Other photovoltaic components are described in subclause 3.2. Photovoltaic systems are described in subclause 3.3.

3.1.1 **amorphous photovoltaic material**

solid-state material in a semi-stable condition with no long-range order in the structural arrangement of the atoms

3.1.2 **amorphous silicon**

see "silicon/amorphous", 3.1.58a).

3.1.3 **anti-reflective coating**

layer formed on the surface of a PV cell to reduce reflective loss

3.1.4 **back surface field effect**

see "effect/back surface field effect", 3.1.25a)

3.1.5 **band gap energy**

(Unit: eV)

amount of energy required to bring an electron from the state of valence electron to the state of free electron

3.1.6 **barrier energy**

(Unit: eV)

energy given up by an electron in penetrating the PV cell barrier

NOTE The barrier energy is a measure of the electrostatic potential of the barrier.

3.1.7 **bus lines**

see "metallisation line/bus bar", 3.1.37a)

3.1.8 **bypass diode (on a module level)**

diode connected across one or more PV cells in the forward electric current direction to allow the PV module electric current to bypass cells to prevent hot spot or hot cell damage resulting from the reverse voltage biasing from the other cells in that module

3.1.9 **cell**

see "photovoltaic/photovoltaic cell", 3.1.43a).

The following terms are used to describe the structure of PV cells and materials.

a) **CIS photovoltaic cell**

PV cell fabricated of copper indium diselenide ($CuInSe_2$, abbreviation CIS) material as a main constituent (thin film type)

b) **compound semiconductor photovoltaic cell**

PV cell made of compound semiconductor, which consists of different chemical elements, such as GaAs (III-V compounds), CdS/CdTe (II-VI compounds), $CdS/CuInSe_2$, etc.

c) **concentrator photovoltaic cell**

see "concentrator photovoltaic cell", 3.8.5a)

d) **dye-sensitized photovoltaic cell**

photoelectrochemical device using dye molecules with two electrodes and an electrolyte

e) **integrated type photovoltaic cell**

multiple PV cells connected in series produced on a single substrate that appears like a single cell

NOTE 1 Integrated type PV cells may include stacked or side-by-side configurations.

f) **multijunction photovoltaic cell**

see "cell/stacked photovoltaic cell", 3.1.9k)

g) **organic photovoltaic cell**

PV cell fabricated of organic materials being polymers and/or small molecules (thin film type)

h) **PN junction photovoltaic cell**

PV cell using a PN junction

NOTE 2 See also "PN junction", 3.1.34f).

i) **Schottky barrier photovoltaic cell**

PV cell using a Schottky junction formed at the metal-semiconductor interface

j) **silicon photovoltaic cell**

PV cell fabricated of silicon material as a main constituent

k) **stacked photovoltaic cell**

PV cell consisting of layers of different PV cells having different optical properties in which incident light is absorbed by each cell layer

l) **tandem photovoltaic cell**

common name for a stack of two or more PV cells behind each other

m) **thin film photovoltaic cell**

PV cell made of thin layers of semiconductor material

NOTE 3 See also "silicon/polycrystalline silicon", 3.1.58e).

3.1.10 cell barrier

very thin electric-potential barrier along the interface between the P-type layer and the N-type layer of a PV cell

NOTE 1 A cell barrier is also known as the "depletion zone".

NOTE 2 An enlectric-potential barrier is a region of high electric field strength opposing the passage of an electrically charged particle in a direction depending on the sign of the electric charge.

3.1.11 cell junction

see "junction/cell junction", 3.1.34a)

3.1.12 CIS photovoltaic cell

see "cell/CIS photovoltaic cell", 3.1.9a)

3.1.13 compound semiconductor photovoltaic cell

see "cell/compound semiconductor photovoltaic cell", 3.1.9b)

3.1.14 conversion efficiency

(Unit: dimensionless, usually expressed as a percentage, %)

ratio of electric power generated by a PV device per unit area to its incident irradiance as measured under standard test conditions, STC

NOTE See also "conditions/standard test conditions", 3.4.16e).

3.1.15 crystalline silicon

see "silicon/crystalline silicon", 3.1.58b).

3.1.16 current

For PV devices and related entries, see "photovoltaic/photovoltaic current", 3.1.43b)

NOTE There are many uses for the electrical term "current".

3.1.17 Czochralski process

see "ingot manufacturing process/Czochralski process", 3.1.32a)

3.1.18 **dark current**

(Unit: A)

electric current remaining in a PV device when its incident irradiance is zero

3.1.19 **device**

see "photovoltaic/photovoltaic device", 3.1.43c)

3.1.20 **diffusion layer**

portion of P-layer or N-layer prepared by a diffusion of dopants to form a PN junction

3.1.21 **directional solidification**

see "ingot manufacturing process/directional solidification", 3.1.32b)

3.1.22 **donor** (in photovoltaic cells)

dopant (such as phosphorus in the case of silicon material) that supplies an additional electron to an otherwise balanced material structure

3.1.23 **dopant** (in photovoltaic cells)

chemical added in small amounts to a semiconductor material to modify its electrical properties

NOTE 1 An N-dopant introduces more electrons than are required for the structure of the material (e.g., phosphorus for silicon material).

NOTE 2 A P-dopant creates electron vacancies in the material structure (e.g., boron for silicon material).

3.1.24 **dye-sensitized photovoltaic cell**

see "cell/dye-sensitized photovoltaic cell", 3.1.9d)

3.1.25 **effect**

see "photovoltaic/photovoltaic effect", 3.1.43d).

a) **back-surface field effect**

effect where the charge carriers generated near the back side of a PV cell are collected effectively by the inner electric field that is formed by a heavily doped zone near the rear electrode

b) **light-confinement effect**

effect where the short-circuit electric current is increased by trapping incident light inside a PV cell using textured surfaces and structures, etc.

3.1.26 **electromagnetic casting**

see "ingot manufacturing process/electromagnetic casting", 3.1.32c).

3.1.27 **energy gap**

(Unit: eV)

smallest energy difference between two neighbouring allowed bands separated by a forbidden band

[IEV 111-14-37]

NOTE See also "band gap energy", 3.1.5).

3.1.28 **float zone melting**

see "ingot manufacturing process/float zone melting", 3.1.32d)

3.1.29 **grid lines**

see "metallisation line/grid line", 3.1.37b)

3.1.30 **heterojunction**

see "junction/heterojunction", 3.1.34b)

3.1.31 **hot spot**

intense localised heating occurring in a PV module when its operating electric current exceeds the reduced short-circuit current of a shadowed or faulty PV cell or group of cells within it

NOTE When a hot spot occurs, the affected cell or group of cells is forced into reverse bias and must dissipate power, which can cause overheating. The voltage bias or damage creates a small, localized shunt path where a large portion of the PV module current appears.

3.1.32 **ingot manufacturing process**

process by which an ingot is manufactured

a) **Czochralski process**

method of growing a perfect large-size single crystal by slowly lifting, under careful cooling conditions, a rotating seed crystal from a counter-rotating molten silicon bath

NOTE 1 The Czochralski process produces a cylindrical-section silicon ingot, which can be cut into wafers that are usually round or pseudo-square.

b) **directional solidification**

method of making large-grain multicrystalline silicon ingots by controlling the cooling rate of molten silicon that has been placed in a square-section crucible

NOTE 2 Directional solidification produces a square-section silicon ingot that can be cut into wafers that are square or rectangular.

c) **electromagnetic casting**

method of making multicrystalline silicon ingots by which a continuously fed square-sectional open-bottom cold crucible of molten silicon is continuously pulled downward through an electromagnetic field

NOTE 3 Electromagnetic casting produces a square-section silicon ingot that can be cut into wafers that are square or rectangular.

d) **float zone melting**

method of growing and purifying high quality single crystal ingots

3.1.33 **integrated type photovoltaic cell**

see "cell/integrated type cell", 3.1.9e)

3.1.34 **junction** (of semiconductors)

transition layer between semiconducting regions of different electrical properties, or between a semiconductor and a layer of a different type, being characterized by a potential barrier impeding the movement of charge carriers from one region to the other

[IEV 521-02-72]

a) cell junction

junction between the P-type semiconductor and N-type semiconductor of a PV cell

NOTE 1 The PV cell junction lies within the cell barrier or depletion zone.

b) heterojunction

PN junction in which the two regions differ in their doping conductivities, and also in their atomic compositions

c) homojunction

PN junction in which the two regions differ in their doping conductivities, but not in their atomic compositions

d) Schottky barrier

junction between a metal and a semiconductor in which a transition region, formed at the surface of the semiconductor, acts as a rectifying barrier

[IEV 521-02-71]

e) PIN junction

junction consisting of an intrinsic semiconductor between a P-type semiconductor and an N-type semiconductor, intended to reduce the recombination of minority carriers

NOTE 2 A PIN junction is widely used in thin film amorphous silicon PV cells.

f) PN junction

junction between a P-type semiconductor and an N-type semiconductor

3.1.35 **light confinement effect**

see "effect/light-confinement effect", 3.1.25b)

3.1.36 **material**

see "photovoltaic/photovoltaic material", 3.1.43e)

3.1.37 **metallisation line**

metallic conductor on the front or back of a PV cell intended to conduct the electric current generated by the PV cell

NOTE 1 A metallisation line can be screen-printed, vapour-deposited or extruded (line-written).

The lines are of two types

a) bus bar (of photovoltaic cells)

metallisation line with a cross-section area greater than that of the grid lines, connected to grid lines and intended to carry their electric current to the wires or ribbons interconnecting the PV cell with other PV cells

NOTE 2 Interconnect wires are connected to the bus bars by soldering or welding.

b) grid line

metallisation line intended to collect electric current from the surface of the semiconductor of the PV cell

3.1.38 **microcrystalline silicon**

see "silicon/microcrystalline silicon", 3.1.58c).

3.1.39 **module**

see "photovoltaic/photovoltaic module", 3.1.43f).

3.1.40 **multicrystalline silicon**

see "silicon/multicrystalline silicon", 3.1.58d).

3.1.41 **multijunction photovoltaic cell**

see "cell/multijunction photovoltaic cell", 3.1.9f).

3.1.42 **organic photovoltaic cell**

see "cell, organic photovoltaic cell", 3.1.9g).

3.1.43 **photovoltaic, photovoltaics**

(Abbreviation: PV)

photovoltaic, adjective

photovoltaics, noun

relating to electrical phenomena caused by the photovoltaic effect

The following terms are commonly used in describing photovoltaic devices. The term "photovoltaic" is commonly referred to "PV". See also "photovoltaic", 3.2.21 and 3.3.56.

a) **photovoltaic cell**

most elementary photovoltaic device

NOTE 1 In solar PV energy system applications, another term for "photovoltaic cell" is "solar photovoltaic cell", colloquially referred to as a "solar cell".

b) **photovoltaic current**

(Unit: A)

DC electric current generated in a photovoltaic device

NOTE 2 See also "dark current", 3.1.18.

c) **photovoltaic device**

component that exhibits the photovoltaic effect

NOTE 3 Examples of a photovoltaic device includes a photovoltaic cell, module or array.

d) **photovoltaic effect**

production of DC voltage by the absorption of photons

NOTE 4 Currently the photovoltaic effect is known to be produced by specifically designed semiconductors. This results in the direct non-thermal conversion of radiant energy into electrical energy.

e) **photovoltaic material**

material that exhibits the photovoltaic effect

f) **photovoltaic module**

complete and environmentally protected assembly of interconnected photovoltaic cells

NOTE 5 Photovoltaic modules can be assembled into photovoltaic panels and photovoltaic arrays. See " photovoltaic/photovoltaic panel" (3.3.56e) and "photovoltaic/photovoltaic array" (3.3.56a).

3.1.44 PIN junction

see "junction/PIN junction", 3.1.34e).

3.1.45 PN junction

see "junction/PN junction", 3.1.34f)

3.1.46 PN junction photovoltaic cell

see "cell/PN junction cell", 3.1.9h)

3.1.47 polycrystalline silicon

see "silicon/polycrystalline silicon", 3.1.58e)

3.1.48 power

(Unit: W)

time-based rate of transferring or transforming energy, or of doing work

NOTE Power is commonly but incorrectly used to mean "electricity" or "electrical".

3.1.49 primary reference photovoltaic cell

see "reference photovoltaic cell/primary reference photovoltaic cell", 3.1.50a)

3.1.50 reference photovoltaic cell

specially calibrated PV cell that is used to measure irradiance or to set simulator irradiance levels to compensate for non-reference spectral irradiance distribution

a) **primary reference photovoltaic cell**

   reference PV cell whose calibration is based on a radiometer or standard detector conforming to the standard World Radiometric Reference (WRR)

b) **secondary reference photovoltaic cell**

   reference PV cell calibrated in natural or simulated sunlight against a primary reference cell

3.1.51 reference photovoltaic device

reference PV cell, package of multiple reference cells or a reference module

3.1.52 reference photovoltaic module

specially calibrated PV module that is used to measure irradiance or to set simulator irradiance levels for measuring the performance of other modules having similar spectral response, optical characteristics, dimensions, and electrical circuitry

3.1.53 ribbon

thin sheet of crystalline or multicrystalline material produced in a continuous process by withdrawal from a molten bath of the parent material (usually silicon)

3.1.54 **Schottky barrier photovoltaic cell**

see "cell/Schottky barrier photovoltaic cell", 3.1.9i).

3.1.55 **Schottky junction**

see "junction, Schottky barrier", 3.1.34d)

3.1.56 **secondary reference photovoltaic cell**

see "reference photovoltaic cell/secondary reference photovoltaic cell", 3.1.50b).

3.1.57 **semiconductor material**

substance, the conductivity of which, due to charge carriers of both signs, is normally in the range between that of conductors and insulating media, and in which the density of its charge carriers can be changed by external means

[IEV 121-12-06] [IEV 521-02-01, modified]

NOTE 1 The term “semiconductor” generally applies where the charge carriers are electrons or holes.

NOTE 2 In order to increase the conductivity, the energy supplied must be greater than the band gap energy. See also "band gap energy", 3.1.5.

NOTE 3 Certain semiconductors, such as silicon, gallium arsenide, cadmium telluride and copper indium diselenide compounds, to name a number of materials currently available, are well suited to the PV conversion process.

3.1.58 **silicon**

(Symbol: Si)

semi-metallic chemical element, atomic weight of 14, an extensively used semiconductor material, a common constituent of sand and quartz in the form of an oxide, and commonly used in PV cells

NOTE 1 Silicon crystallises in a face-centred cubic lattice like a diamond.

NOTE 2 The terms here are applied to materials, wafers, cells, and modules.

a) **amorphous silicon**

(Symbol: a-Si, a-Si:H)

hydrogenated non-crystalline silicon alloy in a semi-stable condition deposited on a foreign substrate with a thickness of the order of 1 µm

b) **crystalline silicon**

(Symbol: c-Si)

general category of silicon materials exhibiting a crystalline structure, i.e., showing long range ordering of the silicon atoms

c) **microcrystalline silicon**

(Symbol: µc-Si)

hydrogenated silicon alloy deposited on a foreign substrate with a thickness of the order of 1 µm presenting grains < 1 µm of crystalline structure

d) **multicrystalline silicon**

(Symbol: mc-Si)

silicon material that has solidified at such a rate that many large grain single crystals (called crystallites, and ranging from 1 mm to 10 mm) are formed

NOTE 3 The atoms of each crystallite are symmetrically arrayed, but the multitude of crystallites is randomly jumbled.

NOTE 4 Often moulded as a cast ingot or pulled ribbon.

e) **polycrystalline silicon**

(Symbol: pc-Si)

silicon material deposited on a foreign substrate as a layer with a thickness of 10 µm to 30 µm and a grain size of 1 µm to 1 mm

NOTE 5 Polycrystalline silicon is known as thin film pc-Si.

NOTE 6 Polycrystalline silicon is also a term used in the feedstock silicon fabrication process.

f) **single crystalline silicon**

(Symbol: sc-Si)

silicon material characterized by an orderly and periodic arrangement of atoms such that it has only one crystal orientation: i.e., all of the atoms are symmetrically arrayed

NOTE 7 Single crystalline silicon is known as mono-crystalline and single crystal.

g) **solar photovoltaic grade silicon**

(Abbreviation: SOG)

feedstock material with a high chemical purity adapted to the growth of crystalline silicon ingots

3.1.59 **silicon photovoltaic cell**

see "cell/silicon photovoltaic cell", 3.1.9j).

3.1.60 **single crystalline silicon**

see "silicon/single crystalline silicon", 3.1.58f).

3.1.61 **solar photovoltaic, solar photovoltaics**

pertaining to PV devices under the influence of sunlight

NOTE All terms beginning with "solar photovoltaic" are listed under their respective "photovoltaic" names (3.1.43, 3.2.21, and 3.3.56).

3.1.62 **stacked photovoltaic cell**

see "cell/stacked photovoltaic cell", 3.1.9k).

3.1.63 **tandem photovoltaic cell**

see "cell/tandem photovoltaic cell", 3.1.9l).

3.1.64 **transparent conducting oxide layer**

(Abbreviation: TCO for Transparent Conducting Oxide)

transparent conducting oxide used as an electrode in thin-film PV cells deposited on transparent glass (superstrate configuration)

NOTE See also "transparent electrode", 3.1.67.

3.1.65 **textured surface**

uneven structure formed on the front surface or back surface of a PV cell to increase the light absorption by decreasing the surface reflection loss and utilizing light confinement effect

3.1.66 **thin film photovoltaic cell**

see "cell/thin film photovoltaic cell", 3.1.9m).

3.1.67 **transparent electrode**

thin film electrode with high electrical conductivity and high optical transmissivity formed on a PV cell

3.1.68 **wafer**

slice of semiconductor material, that forms the mechanical and electrical basis of a crystalline PV cell

3.2 Solar photovoltaic systems components

This subclause addresses vocabulary pertaining to the components of a photovoltaic system except photovoltaic modules (see 3.1). Photovoltaic systems are described in subclause 3.3).

3.2.1 **array**

see "photovoltaic/photovoltaic array", 3.3.56a).

3.2.2 **array cable**

see "photovoltaic/photovoltaic array cable", 3.2.21a).

3.2.3 **array junction box**

see "junction box/array junction box", 3.2.16a).

3.2.4 **automatic start/stop**

function to start and/or stop a power conditioner automatically according to the output of a PV array

3.2.5 **blocking diode**

diode connected in series to PV module(s), panel(s), sub-arrays and array(s) to block reverse electric current into such module(s), panel(s), sub-arrays and array(s)

3.2.6 **bypass diode (on a PV system level)**

diode connected in parallel across one or more PV modules in the forward electric current direction to allow the module current to bypass a module to prevent module overheating and burning resulting from the reverse voltage biasing from the other modules in the PV array

NOTE A bypass diode at a PV system level is also known as a system bypass diode or a bypass device.

3.2.7 **commutation (static inverters)**

control of a power conditioner's AC output waveform

The terms of commutation for power conditioners are listed below.

a) line commutation

type of external commutation where the commutating voltage is supplied from the "line", which normally refers to a utility line

b) **line commutation type**

power conditioner operated with line commutation

c) **self-commutation**

type of commutation where the commutating voltage is supplied by components within the converter or the electronic switch

d) **self-commutation type**

power conditioner operated with self-commutation

3.2.8 **current control type inverter**

see "inverter/current control inverter", 3.2.15a).

3.2.9 **current stiff type inverter**

see "inverter/current stiff inverter", 3.2.15b).

3.2.10 **DC conditioner**

PV system component that changes the PV array output voltage into a useable DC voltage

3.2.11 **DC main cable**

see "photovoltaic/photovoltaic DC main cable", 3.2.21b).

3.2.12 **generator junction box**

see "junction box/generator junction box", 3.2.16b).

3.2.13 **high frequency link type inverter**

see "inverter/high frequency link inverter", 3.2.15f).

3.2.14 **input voltage operating range**

(Unit: V)

input DC voltage range in which the power conditioner operates stably

3.2.15 **inverter**

electric energy converter that changes direct electric current to single-phase or polyphase alternating currents

[IEV 151-13-46]

NOTE 1 An inverter is one of a number of components that is included in the term "power conditioner".

a) **current control inverter**

inverter with an output electric current having a specified sine waveform produced by pulse-width modulated (PWM) control or other similar control system

b) **current stiff inverter**

inverter having an essentially smooth DC input electric current

c) **grid-connected inverter**

inverter that is able to operate in parallel with the distribution or transmission system of an electrical utility

NOTE 2 A grid-connected inverter is also known variously as a grid-intertie or a grid-tied inverter.

d) **grid-dependent inverter**

grid-connected inverter that operates only in grid-dependent mode

e) **grid-interactive inverter**

grid-connected inverter that is able to operate in both stand-alone and parallel modes

NOTE 3 A grid-interactive inverter initiates a grid-parallel mode of operation.

f) **high frequency link inverter**

inverter with a high frequency transformer for electrical isolation between the inverter's input and output circuits

g) **module inverter**

inverter that is integrated to the output of a single PV module

NOTE 4 A module inverter is usually attached to the rear of a module.

NOTE 5 See also "AC module", 3.3.2.

h) **non-islanding inverter**

inverter that ceases to energize an electricity distribution system that is out of the normal operating specifications for voltage and/or frequency

i) **stand-alone inverter**

inverter that supplies a load not connected to the distribution or transmission system of an electrical utility

NOTE 6 A stand-alone inverter is also known as a "battery-powered inverter".

j) **string inverter**

inverter that is designed to operate with a single PV string

NOTE 7 The AC output of a string inverter can be connected in parallel to the output of other string inverters.

k) **transformerless inverter**

inverter without any isolation transformer

l) **utility frequency link inverter**

inverter with a utility frequency transformer for electrical isolation at the inverter output

m) **utility interactive inverter**

inverter used in parallel with the distribution or transmission system of an electrical utility to supply common loads and that may deliver electricity to that distribution or transmission system

n) **voltage control inverter**

inverter with an output voltage having a specified sine waveform produced by pulse-width modulated (PWM) control, etc.

o) **voltage stiff inverter**

inverter having an essentially smooth DC input voltage

3.2.16 junction box

closed or protected enclosure in which circuits are electrically connected

a) **array junction box**

junction box where PV strings are connected

b) **generator junction box**

junction box where PV arrays are connected

3.2.17 **lead-acid battery**

secondary battery with an aqueous electrolyte based on dilute sulphuric acid, a positive electrode of lead dioxide and a negative electrode of lead

NOTE 1 "Secondary" refers to a rechargeable battery.

NOTE 2 Lead-acid batteries are commonly used in stand-alone PV systems.

a) **lead-acid battery for PV systems**

   generic term for lead-acid batteries used in stand-alone PV systems

   NOTE 3 In a narrow sense, a lead-acid battery in PV systems refers to a battery of lead-acid electrochemical cells designed to meet the quality requirements of a PV system.

   NOTE 4 A lead-acid battery in PV systems is commonly referred to as a “PV battery”.

b) **valve regulated lead-acid battery**

   sealed lead-acid battery in which oxygen gas generated from positive plates is reactively absorbed into negative plates thereby suppressing generation of hydrogen gas

   NOTE 5 A valve regulated lead-acid battery is equipped with a valve to release gas outside the battery when pressure builds up in the electrochemical cells.

c) **vented lead-acid battery**

   lead-acid battery designed with a vent mechanism to expel gases generated during charging

3.2.18 **line commutation**

see "commutation/line commutation", 3.2.7a).

3.2.19 **line commutation type**

see "commutation/line commutation type", 3.2.7b).

3.2.20 **non-islanding inverter**

see "inverter/non-islanding inverter", 3.2.15h).

3.2.21 **photovoltaic**

The following terms describe common cabling components of a PV system. See also "photovoltaic" (3.1.43 and 3.3.56).

a) **photovoltaic array cable**

   electrical cable connecting PV arrays to each other

b) **photovoltaic DC main cable**

   cable connecting the generator junction box to the inverter

c) **photovoltaic string cable**

   cable connecting PV modules to form a PV string

d) **photovoltaic supply cable**

   cable connecting the inverter to a distribution circuit of the electrical installation

3.2.22 **power conditioner**

equipment used to convert electricity into a form suitable for subsequent use

NOTE 1 "Power conditioner" is commonly used to mean a piece of equipment comprising an inverter combined with other electrical regulation sub-systems.

NOTE 2 See also "sub-system/power conditioning sub-system" (3.3.75c), and "inverter" (3.2.15).

3.2.23 **pulse width modulation control**

(Abbreviation for Pulse Width Modulation: PWM)

pulse control in which the pulse width or frequency or both are modulated within each fundamental period to produce a certain output waveform [IEC 551-16-30]

3.2.24 **self-commutation**

see "commutation/self-commutation", 3.2.7c).

3.2.25 **self-commutation type**

see "commutation/self-commutation type", 3.2.7d).

3.2.26 **soft-start**

function intended to prevent a voltage dip on the load or the electric power system, which may be caused by the AC output electric current of a starting or re-starting power conditioner

3.2.27 **solar photovoltaic**

see "photovoltaic", 3.1.43.

NOTE All terms beginning with "solar photovoltaic" are listed under their respective "photovoltaic" names (3.1.43, 3.2.21, and 3.3.56).

3.2.28 **stand-alone inverter**

see "inverter/stand-alone inverter", 3.2.15i).

3.2.29 **string cable**

see "photovoltaic/photovoltaic string cable", 3.2.21c).

3.2.30 **string inverter**

see "inverter/string inverter", 3.2.15j).

3.2.31 **supply cable**

see "photovoltaic/photovoltaic supply cable", 3.2.21d).

3.2.32 **support structure**

structure on which PV modules, panels, or arrays are installed

3.2.33 **transformerless type inverter**

see "inverter/transformerless inverter", 3.2.15k).

3.2.34 **utility frequency link type inverter**

see "inverter/utility frequency link inverter", 3.2.15l).

3.2.35 **utility interactive inverter**

see "inverter/utility interactive inverter", 3.2.15m).

3.2.36 **utility interface disconnect switch**

switch at the interface between the PV system and the utility grid

3.2.37 **valve regulated lead-acid battery**

see "lead-acid battery/valve regulated lead-acid battery", 3.2.17b).

3.2.38 **vented lead-acid battery**

see "lead-acid battery/vented lead-acid battery", 3.2.17c).

3.2.39 **voltage control type inverter**

see "inverter/voltage control inverter", 3.2.15n).

3.2.40 **voltage stiff type inverter**

see "inverter/voltage stiff inverter", 3.2.15o).

3.3 Solar photovoltaic systems

This subclause addresses photovoltaic systems as a whole and not as individual components (see 3.1 and 3.2).

3.3.1 **AC/AC interface**

see "interface/AC/AC interface", 3.3.33a).

3.3.2 **AC photovoltaic module**

PV module with an integrated inverter in which the electrical terminals are AC only

3.3.3 **AC side**

see "interface/AC side of the interface", 3.3.33b).

3.3.4 **AC side switchover**

see "photovoltaic system/grid backed-up photovoltaic system/AC side switchover", 3.3.62e).

3.3.5 **array field**

see "photovoltaic/photovoltaic array field", 3.3.56b).

3.3.6 **assembly**

see "photovoltaic/photovoltaic assembly", 3.3.56c).

3.3.7 **backfeed operation**

see "operation/backfeed operation", 3.3.52b).

3.3.8 **balance of system**

(Abbreviation: BOS)

parts of a PV system other than the PV array field, including switches, controls, meters, power conditioning equipment, PV array support structure, and electricity storage components, if any

3.3.9 **centralized photovoltaic system**

see "photovoltaic system/centralized photovoltaic system", 3.3.62a).

3.3.10 **collective electrification system**

(Abbreviation: CES)

small electric generating system and minigrid that supplies electricity to multiple consumption points from a single or multiple energy resource(s)

3.3.11 **DC/DC interface**

see "interface/DC/DC interface", 3.3.33d).

3.3.12 **DC interface**

see "interface/DC interface", 3.3.33c).

3.3.13 **DC side**

see "interface/DC side of the interface", 3.3.33e).

3.3.14 **DC side switchover**

see "photovoltaic system/grid backed-up photovoltaic system /DC side switchover", 3.3.62e).

3.3.15 **dispatchable electric system**

see "power system/dispatchable power system", 3.3.64a).

3.3.16 **dispersed array system**

see "photovoltaic system/dispersed photovoltaic system/ dispersed-array system", 3.3.62b).

3.3.17 **dispersed photovoltaic system**

see "photovoltaic system/dispersed photovoltaic system", 3.3.62b).

3.3.18 **distributed generation PV system**

see "photovoltaic system/distributed generation PV system", 3.3.62c).

See also "distributed generation system", 3.3.19.

3.3.19 **distributed generation system**

facilities and equipment comprising multiple electricity generating systems that are directly connected to and operate in parallel with a distribution system of an electrical utility

3.3.20 distributed generator

(Abbreviation: DG)

electrical generating equipment connected directly to a distributed generation system

NOTE A distributed generator is sometimes called a non-utility generator, abbreviated as a "NUG".

3.3.21 distribution system

electrical facility and its components including poles, transformers, disconnects, relays, isolators and wires that are owned by an electrical utility for the purpose of distributing electrical energy from substations to customers

NOTE In some parts of the world, the distribution system operates at a nominal voltage of 34 500 V.

3.3.22 domestic photovoltaic system

see "photovoltaic system/domestic photovoltaic system", 3.3.62d).

3.3.23 electrical utility

organization responsible for the installation, operation, maintenance and management of all or some portions of major electric generation, transmission, and distribution systems

NOTE "Electrical utility" is preferred over "electric utility".

3.3.24 electrify

1) to supply electricity, electrical circuits, and associated generation, delivery and management equipment
2) to impose a voltage or electric current onto an electrical circuit or device

   NOTE "Electrification" is related to "electrify".

3.3.25 generator

apparatus that converts non-electric energy into electric energy

NOTE 1 A generator does not include energy storage devices or power conditioners.

NOTE 2 See also "photovoltaic/ photovoltaic generator", 3.3.56d).

3.3.26 genset

colloquial term meaning "engine-generator set" consisting of a fuel-driven engine coupled to an electric generator

3.3.27 grid

common reference to an electricity distribution and/or transmission system

NOTE 1 "Electric power network" refers to a grid.

a) microgrid

grid isolated from other grids and that is intended to serve only for the distribution of electricity

NOTE 2 A typical microgrid has a total load of less than 100 kVA and is supplied by micropower systems or micropower stations.

NOTE 3 A microgrid usually serves villages and is supplied by fossil-fuel generators and/or renewable energy generators.

b) **utility grid**

grid for which an electrical utility is responsible

3.3.28 **grid backed-up photovoltaic system**

see "photovoltaic system/grid backed-up photovoltaic system", 3.3.62e).

3.3.29 **grid-connected operation**

see "operation/grid-connected operation", 3.3.52c).

3.3.30 **grid-connected photovoltaic system**

see "photovoltaic system/grid-connected photovoltaic system", 3.3.62f).

3.3.31 **hybrid photovoltaic system**

see "photovoltaic system/hybrid photovoltaic system", 3.3.62g).

3.3.32 **individual electrification system**

(Abbreviation: IES)

small electric power station that supplies electricity to one consumption point, such as a household, usually from a single energy resource

NOTE See also " photovoltaic system/domestic photovoltaic system" (3.3.62d) and "solar home system" (3.3.68).

3.3.33 **interface**

common physical and conceptual boundary between two systems or between two parts of the same system

a) **AC/AC interface**

interface between an inverter and its AC loads

NOTE 1 An AC/AC interface may include AC/AC voltage conversion, filters and connection of auxiliary AC electricity supplies.

b) **AC side of the interface**

part of a grid-connected installation from the AC terminals of the inverter to the point of connection to the distribution system

c) **DC interface**

connections between the PV array field and the input of the power conditioning sub-system

d) **DC/DC interface**

interface between a DC conditioner output and its DC loads

NOTE 2 A DC/DC interface may include DC switchgear, filters and connection of an auxiliary DC electricity supply.

e) **DC side of the interface**

DC part of a grid-connected installation, from the PV modules to the DC terminals of the inverter

f) **utility interface**

interface between the power conditioning sub-system, the local AC load, and the utility grid

NOTE 3 A utility interface may include AC/AC voltage conversion and utility interactive protective functions.

3.3.34 **island**

state in which a portion of the utility grid, containing load and generated electric power, continues to operate isolated from the rest of the utility grid

NOTE 1 The generated electric power and the load in an island may be any combination of customer-owned and utility-owned.

a) **intentional island**

island that is intentionally created, usually to restore or maintain generation of electricity in to a section of the utility grid affected by a fault

NOTE 2 An intentional island includes an agreement between the controlling utility and the operators of customer-owned generation.

b) **unintentional island**

island in which the generation of electricity within the island that is supposed to shut down continues to operate

c) **run-on**

amount of time that an unintentional island exists

NOTE 3 “Run-on” is defined as the interval between the start of an abnormal condition on the distribution system and the time when the distributed generator ceases to energize the distribution system.

NOTE 4 The time represented by run-on is also referred to as "trip time".

3.3.35 **islanding operation**

see "operation/islanding operation", 3.3.52e).

3.3.36 **isolated operation**

see "operation/isolated operation", 3.3.52f).

3.3.37 **isolated photovoltaic system**

see "photovoltaic system/isolated photovoltaic system", 3.3.62h).

3.3.38 **isolated site**

see "site/isolated site", 3.3.67a).

3.3.39 **load offset system**

see "power system/load offset power system", 3.3.64b).

3.3.40 **master control and monitoring sub-system**

see "sub-system/monitor and control sub-system", 3.3.75a).

3.3.41 **merchant power system**

see "power system/merchant power system", 3.3.64c).

3.3.42 **micropower system**

see "power system/micropower system", 3.3.64d).

3.3.43 **mode**

state in which a PV system or an inverter is operating

NOTE For definitions of various modes of operation, see "operation", 3.3.52.

3.3.44 monitor and control sub-system

see "sub-system/monitor and control sub-system", 3.3.75a).

3.3.45 multi-dispersed photovoltaic system

see "photovoltaic system/dispersed photovoltaic system/multi-dispersed photovoltaic system", 3.3.62b).

3.3.46 multi-source photovoltaic system

see "photovoltaic system/multi-source photovoltaic system", 3.3.62i).

3.3.47 non-dispatchable power system

see "power system/non-dispatchable", 3.3.64e)

3.3.48 non-domestic photovoltaic system

see "photovoltaic system/non-domestic photovoltaic system", 3.3.62j).

3.3.49 off-grid operation

see "operation/off-grid operation", 3.3.52g)

3.3.50 off-grid photovoltaic system

see "photovoltaic system/off-grid photovoltaic system", 3.3.62k).

3.3.51 on-grid

see "operation/grid-connected operation", 3.3.52c).

3.3.52 operation (photovoltaics)

combination of activities necessary to permit a PV system or its components to function

[IEV 151-11-28, modified]

NOTE 1 Operation includes switching, controlling, monitoring and maintenance as well as any work activities.

a) **autonomous operation**

   also known as stand-alone operation (3.3.52i)

b) **backfeed operation**

   mode of operation when electric power flows from a generating system into a utility grid

   NOTE 2 Backfeed operation arises when the generating system generates more electricity than is used by local electrical loads.

c) **grid-connected operation**

   mode of operation in which a PV system is electrifying loads in parallel with a utility grid

   NOTE 3 In a grid-connected operation, site loads will be electrified by either or both the utility or the PV system.

   NOTE 4 Electricity will be able to flow into the utility if the utility permits backfeed operation.

d) **grid-dependent operation**

mode of operation in which a grid-connected inverter depends on the utility grid to initiate and continue the inverter's operation

e) **islanding operation**

mode of operation for operating an island

NOTE 5 Islanding operation includes maintaining frequency, voltage, power reserve, and instantaneous active and reactive power requirements.

f) **isolated operation**

stable and temporary operation of a discrete part of a grid

NOTE 6 See also IEV 603-04-33.

g) **off-grid operation**

also known as stand-alone operation (3.3.52i)

h) **parallel operation**

mode of operation when a grid-connected generator is supplying electricity to the grid or site loads at the same time as a utility grid

NOTE 7 Parallel operation is also known as grid-parallel operation.

i) **stand-alone operation**

mode of operation in which loads are electrified solely by the PV system and not in parallel with a utility grid

3.3.53 **panel**

see "photovoltaic/photovoltaic panel", 3.3.56e).

3.3.54 **parallel circuit of modules**

circuit in which PV modules are connected in parallel

3.3.55 **parallel operation**

see "operation/parallel operation", 3.3.52h).

3.3.56 **photovoltaic**

The following terms describe common sub-assemblies of a photovoltaic array field. See also "photovoltaic", 3.1.43 and 3.2.21.

a) **photovoltaic array**

assembly of mechanically integrated and electrically interconnected PV modules, PV panels or PV sub-arrays and its support structure

NOTE 1 A PV array does not include its foundation, tracking apparatus, thermal control, and other such components.

b) **photovoltaic array field**

aggregate of all PV arrays within a given PV system focusing on the mechanical arrangement of the PV technology

c) **photovoltaic assembly**

PV components that are installed outdoors and remote from its loads, including modules, support structure, foundation, wiring, tracking apparatus, and thermal control (where specified), and including junction boxes, charge controllers and inverters depending on the assembly's installed configuration

NOTE 2 Examples of a PV assembly are the PV components on the roof or in the yard of a PV-electrified house, as different from the components of the PV system that are installed inside the house.

d) **photovoltaic generator**

generator that uses the photovoltaic effect to convert sunlight into electricity

NOTE 3 The PV generator is the PV array in a PV system.

NOTE 4 A PV generator does not include energy storage devices or power conditioners.

e) **photovoltaic panel**

PV modules mechanically integrated, pre-assembled and electrically interconnected

f) **photovoltaic string**

circuit of series-connected PV modules

g) **photovoltaic sub-array**

portion of a PV array that can be considered as a unit

3.3.57 **photovoltaic components**

parts of a PV system

NOTE PV components could include, for example, modules, inverters, electrical storage devices, and other balance of system components.

3.3.58 **photovoltaic installation**

constructed components of a PV system

3.3.59 **photovoltaic energy system**

another term for a PV power system, 3.3.61

3.3.60 **photovoltaic plant**

another term for a PV system

NOTE A PV plant is also known as a PV power station. Such plants are normally grid-connected and large.

3.3.61 **photovoltaic power system**

(Abbreviation: PVPS)

photovoltaic system

3.3.62 **photovoltaic system**

assembly of components that produce and supply electricity by the conversion of solar energy

NOTE 1 The PV component list and PV system configuration varies according to the application, and could also include the following sub-systems: power conditioning, storage, system monitoring and control and utility grid interface.

The following terms describe common system configurations.

a) **centralized photovoltaic system**

grid-connected PV system that generates bulk electricity

b) **dispersed photovoltaic system**

PV system that consists of multiple dispersed PV generators or PV systems operating as if they were a single PV generator or system

Dispersed photovoltaic systems can be classified as follows:

– **dispersed-array photovoltaic system**

PV system that connects multiple dispersed PV arrays in parallel to feed centrally located inverters

– **multi-dispersed photovoltaic system**

PV system that operates multiple, parallel, dispersed PV systems through distribution lines with a common control system

c) **distributed generation PV system**

PV system that is also a distributed generation system

d) **domestic photovoltaic system**

PV system that electrifies household loads

NOTE 2 See also "solar home system", 3.3.68.

e) **grid backed-up photovoltaic system**

PV system that switches over to a utility electricity source when the PV output is less than load requirements

Grid backed-up photovoltaic systems can be classified as follows:

– **AC side switchover**

PV system in which the utility grid is connected to the AC side of the system

– **DC side switchover**

PV system in which the utility grid is connected through a rectifier into the DC side of the system

f) **grid-connected photovoltaic system**

PV system that functions only in a grid-connected mode of operation

NOTE 3 Also known as "utility intertied", "utility interconnected", or "grid-tied".

g) **hybrid photovoltaic system**

see "multi-source photovoltaic system", 3.3.62i).

h) **isolated photovoltaic system**

PV system that functions only in an isolated mode of operation

NOTE 4 Also known as a "stand-alone photovoltaic system".

i) **multi-source photovoltaic system**

PV system operating in parallel with other electricity generators

NOTE 5 Also called a "PV-hybrid" system.

j) **non-domestic photovoltaic system**

PV system used for a purpose that is not a domestic purpose (e.g., providing electricity for a telecommunication relay, water pumping, remote communication, safety and protection devices, etc.)

k) **off-grid photovoltaic system**

PV system that functions only in an off-grid mode of operation

NOTE 6 Also known as a "stand-alone photovoltaic system".

l) **off-grid domestic photovoltaic system**

stand-alone PV system installed so as to electrify households

NOTE 7 Also referred to as a solar home system.

m) **off-grid non-domestic photovoltaic system**

stand-alone PV system used for a variety of applications such as water pumping, remote communications, telecommunication relays, safety and protection devices, etc.

n) **stand-alone photovoltaic system**

PV system that functions only in a stand-alone mode of operation

NOTE 8 See "operation/stand-alone operation", 3.3.52i).

o) **utility interactive photovoltaic system**

grid-connected PV system that is able to function in an isolated mode or in a parallel mode of operation

p) **off-grid village photovoltaic system**

stand-alone PV system electrifying a village

3.3.63 **power conditioning sub-system**

see "sub-system/power conditioning sub-system", 3.3.75c).

3.3.64 **power system**

installation to generate electricity, including civil engineering works, energy conversion equipment and all the necessary ancillary equipment

[IEV 601-03-01, modified]

NOTE 1 A power system is also known as a power station or an electric generating station.

a) **dispatchable power system**

grid-connected generating system that is capable of generating electricity as required by its interconnected electrical distribution system

NOTE 2 For example, a fossil-fuelled engine-powered generator is dispatchable.

b) **load offset power system**

grid-connected generating system that only exports electrical energy to the electrical distribution system that is in excess of the on-site loads

c) **merchant power system**

grid-connected generating system whose sole purpose is to generate electricity for the electrical distribution system, not on-site loads

d) **micropower system or micropower station**

generating system that is intended to serve only for the generation of electricity to site loads, a microgrid, or a utility distribution system

NOTE 3 The typical generating capacity of a micropower system is less than 100 kVA.

e) **non-dispatchable power system**

generating system that is not able to generate electricity as required by the loads

NOTE 4 For example, a renewable energy generator is a non-dispatchable.

3.3.65 **remote site**

see "site/remote site", 3.3.67b).

3.3.66 **safety disconnect control and monitoring sub-system**

see "sub-system/safety disconnect control and monitoring sub-system", 3.3.75d).

3.3.67 **site**

geographical location of a system

a) **isolated site**

location not connected to the utility grid

b) **remote site**

location far from developed infrastructures, specifically the utility grid

3.3.68 **solar home system**

(Abbreviation: SHS)

stand-alone PV system installed in a household

NOTE See also " photovoltaic system/domestic photovoltaic system" (3.3.62d) and "individual electrification system" (3.3.32).

3.3.69 **solar photovoltaic**

NOTE All terms beginning with "solar photovoltaic" are listed under their respective "photovoltaic" names (3.1.43, 3.2.21, and 3.3.56).

3.3.70 **stand-alone operation**

see "operation/stand-alone operation", 3.3.52i).

3.3.71 **stand-alone photovoltaic system**

see "photovoltaic system/stand-alone photovoltaic system", 3.3.62n).

3.3.72 **storage sub-system**

see "sub-system/storage sub-system", 3.3.75e).

3.3.73 **string**

see "photovoltaic/ photovoltaic string", 3.3.56f).

3.3.74 **sub-array**

see "photovoltaic/photovoltaic sub-array", 3.3.56g).

3.3.75 **sub-system**

assembly of components

The following terms describe common sub-systems:

a) **monitor and control sub-system**

(Abbreviation: MCM)

logic and control component(s) that supervise(s) the overall operation of the system by controlling the interaction between all sub-systems

b) **photovoltaic generator sub-system**

components that convert light energy into electricity using the PV effect

c) **power conditioning sub-system**

component(s) that convert(s) electricity from one form into another form that is suitable for the intended application

NOTE A power conditioning sub-system could include a charge regulator that converts DC to DC, an inverter that converts DC to AC, or a charger or rectifier that converts AC to DC.

d) **safety disconnect control and monitoring sub-system**

component(s) that monitor(s) utility grid conditions and open(s) a safety disconnect for out-of-bound conditions

e) **storage sub-system**

component(s) that store(s) energy

3.3.76 **system**

see "photovoltaic system", 3.3.62)

3.3.77 **utility grid**

see "grid/utility grid", 3.3.27b)

3.3.78 **utility interactive photovoltaic system**

see "photovoltaic system/utility interactive photovoltaic system", 3.3.62o)

3.3.79 **utility interface**

see "interface/utility interface", 3.3.33f)

3.4 Solar photovoltaic system and component performance parameters

This subclause describes performance parameters of the various components of the PV systems and the system themselves.

3.4.1 **acceptance test conditions**

see "conditions/acceptance test conditions", 3.4.16a)

3.4.2 **ampere-hour efficiency**

see "efficiency/ampere-hour efficiency", 3.4.26a)

3.4.3 **aperture area**

see "cell area/active cell area", 3.4.11b), and "module area/active module area" 3.4.46b)

3.4.4 **area**

see "cell area/active cell area", 3.4.11b), and "module area/active module area" 3.4.46b)

3.4.5 **array capture losses**

see "losses/array capture losses", 3.4.40a)

3.4.6 **array efficiency**

see "efficiency/array efficiency", 3.4.26b)

3.4.7 **array yield**

see "yield/array yield", 3.4.96a)

3.4.8 **assumed non-sunshine period**

period of time in which a stand-alone PV system equipped with an electrical storage device is assumed, at the time of system-design, to not generate electricity continuously

3.4.9 **BOS losses**

see "losses/balance of system losses", 3.4.40b)

3.4.10 **capacity**

a) **array capacity**

(Unit: W)

rated power generation of a PV array

b) **capacity factor**

(Symbol: L_{SP}) (Unit: dimensionless, usually expressed as a percentage (%) over a period of time such as a month or year)

ratio of the output energy of system (W_{SP}) to the product of rated PV array output (P_0) and operating time

c) **installed capacity**

see "rated capacity", 3.4.10d).

d) **rated capacity**

(Unit: Ah, or Wh)

Pertaining to storage devices: quantity of charge (or energy) that can be delivered by the storage device under specified conditions

Pertaining to PV devices: see "rated/rated power", 3.4.69f).

Pertaining to PV systems: see "power/rated system power", 3.4.69j).

e) **residual capacity**

(Unit: Ah, or Wh)

quantity of charge (or energy) remaining in an electrical storage device following a partial discharge

3.4.11 **cell area**

(Unit: m^2)

total or active area of a photovoltaic cell

a) **total cell area**

area of the front surface of a photovoltaic cell as defined by its outer edges

NOTE 1 Total cell area includes the area of any metallisation lines.

NOTE 2 Total cell area is preferred for reporting cell efficiency.

b) **active cell area**

part of the total cell area designed to receive solar radiation for the generation of electricity

NOTE 3 Active cell area equals the total cell area minus the area contribution of the metallisation lines.

NOTE 4 Active cell area is sometimes referred to as “cell aperture area”.

3.4.12 **cell junction temperature**

(Symbol: T_j) (Unit: °C)

temperature measured by a thermal sensor in contact with the PV cell or derived from V_{oc} measurement or thermal balance calculations

3.4.13 **charging efficiency**

see "efficiency/charging efficiency", 3.4.26c).

3.4.14 **coefficient**

a) current-temperature coefficient

(Symbol: α) (Unit: A·K^{-1} (absolute), K^{-1} (relative))

change of the short-circuit electric current of a PV device per unit change of temperature

NOTE 1 Both absolute and relative values are used.

NOTE 2 The user is cautioned to be aware of the difference between the absolute and the relative unit of measure, and to use the appropriate coefficient with the proper equation.

NOTE 3 If the current-temperature coefficient has the unit of A·K^{-1}, the value of the coefficient is a function of the series-parallel circuit arrangement. For example, a 36-cell PV module will have different coefficients if all 36 cells are connected in series versus a circuit with three parallel strings of 12 series-connected cells in each.

NOTE 4 The short-circuit current varies with irradiance and to a lesser extent with temperature.

b) voltage-irradiance coefficient

(Symbol: δ) (Unit: dimensionless)

ratio-change of the open-circuit voltage (V_{oc1} / V_{oc2}) of a PV device as a function of the ratio-change of the natural logarithm of irradiance, ln(G_1 / G_2)

c) voltage-temperature coefficient

(Symbol: β) (Unit: V·K^{-1} (absolute), K^{-1} (relative))

change of the open circuit voltage of a PV cell per unit change of cell junction temperature

NOTE 5 The user is cautioned to be aware of the difference between the absolute and the relative unit of measure, and to use the appropriate coefficient with the proper equation.

NOTE 6 If the voltage-temperature coefficient has the unit of V·K^{-1}, the value of the coefficient is a function of the series-parallel circuit arrangement. For example, a 36-cell PV module will have different coefficients if all 36 cells are connected in series versus a circuit with three parallel strings of 12 series-connected cells in each.

3.4.15 **collection efficiency**

see "efficiency/collection efficiency", 3.4.26d).

3.4.16 **conditions**

conditions under which a PV device is evaluated

NOTE The conditions under which a PV device is evaluated typically specify irradiance, ambient temperature, spectral distribution and/or air mass.

a) acceptance test conditions

(Abbreviation: ATC)

reference values of ambient temperature, in-plane irradiance and spectral distribution specified for the power rating of a PV device

b) operating conditions

conditions under which a PV device is operating

c) optional test conditions

test irradiance as measured with a reference PV device of 1 000 W·m^{-2} and PV cell junction temperature at any conveniently measured ambient conditions

d) standard operating conditions

(Abbreviation: SOC)

operating values of in-plane irradiance (1 000 $W \cdot m^{-2}$), PV device junction temperature equals the nominal operating PV cell junction temperature (NOCT), and air mass (AM = 1,5)

e) standard test conditions

(Abbreviation: STC)

reference values of in-plane irradiance ($G_{I,ref}$ = 1 000 $W \cdot m^{-2}$), PV cell junction temperature (25°C), and air mass (AM = 1,5) to be used during the testing of any PV device

f) test conditions

conditions under which a device is tested

3.4.17 **conversion efficiency**

see "efficiency/PV conversion efficiency", 3.4.26e).

3.4.18 **conversion factor**

(Unit: dimensionless, usually expressed as a percentage, %)

ratio of the output to the input fundamental power of a device, component or system

3.4.19 **current density (photovoltaic cell)**

(Symbol: J) (Unit: $A \cdot cm^{-2}$)

electric current output of a PV cell divided by the cell area (either the total area or the active area)

3.4.20 **current-temperature coefficient**

see "coefficient/current-temperature coefficient", 3.4.14a).

3.4.21 **current-voltage characteristic**

(Symbol: I-V) (Equation: $I = f(V)$)

output electric current of a PV device as a function of output voltage, at a particular temperature and irradiance

NOTE 1 IEC/ISO rules stipulate that the symbol for voltage is "U", whereas the many industries engaging with electricity use the symbol "V". In keeping with normal convention, the PV industry also uses "V" and thus the symbol "I-V" to describe the current-voltage characteristic.

NOTE 2 Sometimes the industry uses "IV" as the symbol. The use of "I-V" is less ambiguous than "IV", which also means "four" in roman numbering.

3.4.22 **DC ripple factor**

(Unit: dimensionless, usually expressed as a percentage, %)

ratio of half the difference between the maximum and minimum value to the mean value of a pulsating direct electric current

NOTE Low values of DC ripple factor approximately equal the ratio of the difference between the maximum and minimum value to the sum of the maximum and the minimum value.

3.4.23 **dependency on solar energy**

(Symbol: D_P) (Unit: dimensionless, usually expressed as a percentage (%) over a period of time such as a month or year)

in the case of a multi-source generating system, ratio of system output electricity (W_{SP}) to the sum of output electricity and any non-photovoltaic electricity (W_{BP})

3.4.24 **depth of discharge**

(Abbreviation: DOD) (Unit: dimensionless, usually expressed as a percentage, %)

value to express the state of discharge of an electrical storage device

NOTE The ratio of the discharge amount to the rated capacity is generally used.

3.4.25 **effective energy efficiency**

see "efficiency/effective energy efficiency", 3.4.26f).

3.4.26 **efficiency**

(Symbol: η is commonly used.) (Unit: dimensionless, usually expressed as a percentage, %)

ratio of output quantity to input quantity

NOTE 1 The quantity specified by the term "efficiency" is normally the power, energy, or electric charge produced by or delivered to a component.

a) **ampere-hour efficiency**

(Symbol: η_{Ah})

ratio of the amount of electrical charge removed during discharge conditions to the amount of electrical charge added during charge conditions in an electrical energy storage device

It is calculated by:

$$\eta_{Ah} = I_d\ T_d\ /\ (I_c\ T_c);$$

where

η_{Ah} is ampere-hour efficiency;

I_d is discharge electric current (A);

T_d is discharge time (h);

I_c is charge electric current (A);

T_c is charge time (h).

b) **array efficiency**

sunlight to electricity conversion efficiency of the PV array

c) **charging efficiency**

generic term to express ampere-hour efficiency (or less commonly, watt-hour efficiency in an energy storage device

d) **collection efficiency**

ratio of the number of electrons flowing out of a PV cell to the number of incident photons in a short-circuit condition

e) **PV conversion efficiency**

ratio of maximum PV output to the product of PV device area and incident irradiance measured under specified test conditions, usually standard test conditions, STC

NOTE 2 See also "conditions/standard test conditions", 3.4.16e).

f) effective energy efficiency

energy efficiency during an identified period

g) inverter efficiency

ratio of the useful inverter output power to its input power, or output energy to its input energy

h) mean array efficiency

(Symbol: η_{Amean})

average PV array efficiency

NOTE 3 Mean PV array efficiency is useful for comparison with the rated PV array efficiency.

NOTE 4 The difference between mean and rated efficiency represents diode, wiring, mismatch and other losses during PV system operation.

i) overall system efficiency

(Symbol: η_{tot})

efficiency of the whole system including all the electricity sources

NOTE 5 Overall system efficiency is derived from the electricity supplied to the loads based on the solar irradiation and fuel supplies.

j) partial efficiency

ratio of output power to input power, or output energy to input energy), when a component is operating below its rated output

k) partial load efficiency

ratio of the effective inverter output power to its input power, or output energy to input energy, at a specified load

l) power efficiency

ratio of active output power to active input power

m) rated efficiency

Pertaining to a PV device: efficiency of a device at specified operating conditions, usually standard test conditions, STC

NOTE 6 See also "conditions/standard test conditions", 3.4.16e).

Pertaining to an inverter: efficiency of an inverter when it is operating at its rated output

n) system efficiency

(Symbol: η_{SP}) (Unit: dimensionless, usually expressed as a percentage (%) over a period of time such as a month or year)

ratio of PV system output energy (W_{SP}) to the product of total irradiation (Q_{ASP}) and PV array area (A_P)

It is calculated by:

$$\eta_{SP} = W_{SP} / (Q_{ASP}\, A_P)$$

where

η_{SP} is system efficiency;

W_{SP} is system output energy (J);

Q_{ASP} is total irradiation ($J{\cdot}m^{-2}$);

A_P is array area (m^2).

o) efficiency tolerance

(Unit: dimensionless, usually expressed as a percentage, %)

permissible tolerance between the manufacturer's specified efficiency and the measured efficiency

p) watt-hour efficiency

(Symbol: η_{Wh})

ratio of the amount of electrical energy removed during discharge conditions to the amount of electrical energy added during charge conditions in an electrical energy storage device

It is calculated by:

$$\eta_{Wh} = I_d\, T_d\, V_{dav} / (I_c\, T_c\, V_{cav}) = \eta_{Ah}\, V_{dav} / V_{cav}$$

where

η_{Wh} is watt-hour efficiency;

I_d is discharge electric current (A);

T_d is discharge time (h);

V_{dav} is average discharge voltage (V);

I_c is charge electric current (A);

T_c is charge time (h);

V_{cav} is average charge voltage (V).

NOTE 7 In calculating watt-hour efficiency, the ratio of average voltage to the specified final discharge voltage is often used, rather than voltages at any specified time.

q) weighted average conversion efficiency

method of estimating the effective energy efficiency

NOTE 8 Weighted average conversion efficiency is calculated as the sum of products of each power level efficiency and related weighting coefficients depend on a regional irradiance duration curve. When a PV system is a stand-alone type with a storage sub-system, the weighting coefficients depend on the load duration curve.

3.4.27 electromagnetic interference

(Abbreviation EMI)

degradation of the performance of equipment, a transmission channel or a system caused by an electromagnetic disturbance

[IEV 161-01-06]

3.4.28 **energy**

(Unit: J, though kWh is commonly used in the electrical industry)

ability of a physical system to do work

[IEV 111-13-29, modified]

a) photovoltaic energy

electric energy generated by a PV system, not including the electric energy supplied by non-photovoltaic components

3.4.29 **equivalent photovoltaic cell temperature**

(Abbreviation: ECT) (Unit: °C)

cell junction temperature at which the measured electrical output of a PV device would be produced if the entire device were operating uniformly at this junction temperature

3.4.30 **fill factor**

(Abbreviation: FF) (Unit: dimensionless, usually expressed as a percentage, %)

ratio of maximum PV device output power to the product of open-circuit voltage and short-circuit electric current

It is calculated by:

$$FF = P_{max} / (V_{oc} I_{sc})$$

NOTE Fill factor is often used to indicate the electricity production quality of a device.

3.4.31 **final annual yield**

see "yield/final annual yield", 3.4.96b)

3.4.32 **final system yield**

see "yield/final system yield", 3.4.96c)

3.4.33 **fixed voltage operation**

control strategy whereby PV system operation is always a constant voltage near the maximum power voltage of the PV array

NOTE See also " maximum power/maximum power point tracking", 3.4.42d).

3.4.34 **installed capacity**

see "capacity/installed capacity", 3.4.10c)

3.4.35 **installed power**

see " maximum power/maximum power under standard test conditions", 3.4.42g)

3.4.36 **inverter efficiency**

see "efficiency/inverter efficiency", 3.4.26g)

3.4.37 **inverter mismatch loss**

see "mismatch loss/inverter mismatch loss", 3.4.45a)

3.4.38 **linearity**

amount of deviation from a straight line function of a performance parameter such as short-circuit electric current or open circuit voltage versus an environmental variable such as irradiance or temperature

NOTE 1 Usually, linearity is expressed as a normalised standard deviation of the line slope.

NOTE 2 PV cell, module and system performance evaluations frequently employ linear equations to translate performance from one set of temperature and irradiance conditions to another. Linearity is evaluated by a process in which the best straight-line function is mathematically determined from a set of data points, and then the variation of the data points from this line used in calculations that determines the linearity.

3.4.39 **load**

electrical component that converts electrical energy into a form of useful energy and only operates when voltage is applied

NOTE See also IEV 151-15-15.

a) **load current**

(Symbol: I_L) (Unit: A)

electric current supplied to a load by a PV system

b) **load power**

(Symbol: P_L) (Unit: W)

electric power supplied to a load by a PV system

c) **load voltage**

(Symbol: V_L) (Unit: V)

voltage supplied across the terminals of a load by a PV system

d) **negative load**

as seen from the utility, a type of load in which electric energy supplied by a generating system flows into a utility distribution system

3.4.40 **losses**

(Unit: W, J, though kWh is commonly used in the electrical industry)

electric power or energy that does not result in the service that is intended

NOTE 1 See also IEV 151-15-26.

a) **array capture losses**

(Symbol: L_c)

normalised losses of a given PV system due to the energy losses of its PV array

NOTE 2 PV array capture losses are found from the difference between the reference yield and the PV array yield. These losses arise from mis-match losses, conversion losses, array soiling, etc.

b) **balance of system losses**

(Symbol: L_{BOS})

normalised losses of a given PV system due to the energy losses of its BOS components

c) **normalised losses**

(Unit: J·kW^{-1} Usually expressed as kWh·kW^{-1} over any convenient unit of time. Commonly it is calculated over a day, which then gives a unit of h·d^{-1})

duration that a PV device or PV system would need to operate at its rated power to compensate for the energy losses of that PV device or PV system

NOTE 3 Normalised losses are commonly calculated from a difference in given yields.

3.4.41 **maximum input voltage**

(Unit: V)

maximum DC voltage range of a power conditioner at a specified operating condition, such as the open circuit voltage (V_{OC}) of a PV array

3.4.42 maximum power

(Symbol: P_{max}, may also be known as P_{mpp}) (Unit: W)

power generated at the maximum power point

a) **maximum power current**

(Symbol: I_{Pmax}) (Unit: A)

electric current at the conditions of maximum power

b) **maximum power irradiance coefficient**

(Symbol: χ) (Unit: dimensionless)

ratio-change of the maximum power (P_{max1} / P_{max2}) of a PV device as a function of the ratio-change of the natural logarithm of irradiance, $\ln(G_1 / G_2)$

c) **maximum power point**

(Abbreviation: MPP)

point on a PV device's current-voltage characteristic where the product of electric current and voltage yields the maximum electrical power under specified operating conditions

d) **maximum power point tracking**

(Abbreviation: MPPT)

control strategy whereby PV array operation is always at or near the maximum power point

NOTE 1 See also "fixed voltage operation", 3.4.33.

e) **maximum power temperature coefficient**

(Symbol: γ) (Unit: $W \cdot K^{-1}$ (absolute), K^{-1} (relative))

change of the maximum power of a PV device per unit change of temperature

NOTE 2 Both absolute and relative values are used.

NOTE 3 The user is advised to be aware of the difference between the absolute and the relative unit of measure, and to use the appropriate coefficient with the proper equation.

f) **maximum power under standard operating conditions**

maximum power output of a PV device under standard operating conditions, SOC

NOTE 4 See also " conditions/standard operating conditions", 3.4.16d).

g) **maximum power under standard test conditions**

maximum power output of a PV device under standard test conditions, STC

NOTE 5 See also " conditions/standard test conditions", 3.4.16e).

h) **maximum power voltage**

(Symbol: V_{Pmax}) (Unit: V)

voltage at the conditions of maximum power

i) **maximum power voltage under standard operating conditions**

(Unit: V)

voltage at the maximum power point of a PV device under standard operating conditions, SOC

NOTE 6 See also " conditions/standard operating conditions", 3.4.16d).

j) **maximum power voltage under standard test conditions**

(Unit: V)

voltage at the maximum power point of a PV device under standard test conditions, STC

NOTE 7 See also " conditions/standard test conditions", 3.4.16e).

3.4.43 mean array efficiency

see "efficiency/mean array efficiency", 3.4.26h).

3.4.44 mismatch error

see "spectral responsivity/spectral response mismatch error", 3.4.82a).

3.4.45 mismatch loss

a) **inverter mismatch loss**

(Unit: W or dimensionless and expressed as a percentage, %)

power loss produced when a power conditioner is operating at a different input voltage or electric current from the voltage at the maximum power point or the electric current at the maximum power

b) **module mismatch loss**

(Unit: W or dimensionless and expressed as a percentage, %)

difference between the total maximum power of PV devices connected in series or parallel and the sum of each device measured separately under the same conditions

NOTE PV module mismatch loss arises because of differences in individual device I-V characteristics.

3.4.46 module area

(Unit: m^2)

total or active area of a photovoltaic module

a) **total module area**

area of the front surface of a photovoltaic module as defined by its outer edges

NOTE 1 Total module area includes the total area of the photovoltaic cells plus the area of space not covered by the cells. The area of the front surface of the frame (if any) is included.

NOTE 2 Total module area is preferred for reporting module efficiency.

b) **active module area**

part of the total module area designed to receive solar radiation for the generation of electricity

NOTE 3 Active module area equals the sum of the total cell area in the module.

NOTE 4 Active module area is sometimes referred to as "module aperture area".

3.4.47 module mismatch loss

see "mismatch loss/module mismatch loss", 3.4.45b).

3.4.48 module packing factor

(Unit: dimensionless, usually expressed as a percentage, %)

ratio of the total PV cell area to the module area

3.4.49 module surface temperature

(Unit: °C)

mean temperature of the back surface of a PV module

3.4.50 **module temperature**

(Unit: °C)

mean value of the temperatures of cell junctions in a PV module

3.4.51 **no load loss**

(Unit: W)

input power of the power conditioner when its load is disconnected

3.4.52 **nominal operating photovoltaic cell temperature**

(Abbreviation: NOCT) (Unit: °C)

equilibrium mean PV cell junction temperature within a module under reference conditions of 800 W·m^{-2} irradiance, 20°C ambient air temperature, 1 m·s^{-1} wind speed, electrically open-circuit and open-rack mounted at normal incidence, at solar noon

3.4.53 **nominal system power**

(Unit: W)

PV system's DC power that is generated at standard operating conditions, SOC, when connected with a load determined by a prescribed PV array

NOTE 1 When stating nominal system power conditions, nominal system output voltage is represented by the output voltage (V), and nominal system output electric current is represented by the output current (A).

NOTE 2 See also "conditions/standard operating conditions", 3.4.16d).

3.4.54 **non-uniformity**

(Unit: dimensionless, usually expressed as a percentage, %)

uniformity of solar simulator irradiance on the PV module during a test

NOTE 1 Non-uniformity is calculated from the difference in maximum irradiance minus the minimum irradiance measured over the test area, divided by the sum of the maximum irradiance and the minimum irradiance.

NOTE 2 The area scanned to find the minimum and maximum irradiance may be the solar simulator test plane, or it may be the module footprint.

3.4.55 **normalised losses**

see "losses/normalised losses", 3.4.40c).

3.4.56 **open-circuit voltage (photovoltaic devices)**

(Symbol: V_{OC}) (Unit: V)

voltage at the output terminals of a PV device at a particular temperature and irradiance when the output electric current of the PV device is zero

a) **open-circuit voltage under standard test conditions**

(Symbol: $V_{OC\ STC}$)

open-circuit voltage as measured under standard test conditions, STC

NOTE See also "conditions/standard test conditions", 3.4.16e).

3.4.57 **operating conditions**

see "conditions/operating conditions", 3.4.16b).

3.4.58 **optional test conditions**

see "conditions/optional test conditions", 3.4.16c).

3.4.59 **overall system efficiency**

see "efficiency/overall system efficiency", 3.4.26i).

3.4.60 **overload capability**

(Unit: dimensionless, usually expressed as a percentage (%) and minutes)

output power level beyond which permanent damage occurs to a device

NOTE Overload capability is the ratio of overload power to rated load power for a period of time.

3.4.61 **partial efficiency**

see "efficiency/partial efficiency", 3.4.26j).

3.4.62 **partial load efficiency**

see "efficiency/partial load efficiency", 3.4.26k).

3.4.63 **partial state of charge**

Abbreviation: PSOC

see "state of charge/partial state of charge", 3.4.86a).

3.4.64 **peak power**

see "rated/rated power", 3.4.69f).

3.4.65 **peak sun hours**

see "rated/rated sun-hours", 3.4.69i).

3.4.66 **performance ratio**

(Symbol: R_P) (Unit: dimensionless, usually expressed as a percentage, %)

index that shows the effect of PV system losses on the rated PV array capacity

NOTE 1 Typically, PV system losses are due to PV array temperature, incomplete utilisation of the irradiation and PV system component inefficiencies or failures.

NOTE 2 The performance ratio is commonly calculated from the ratio of the final system yield over the reference yield.

3.4.67 **photovoltaic energy**

see "energy/photovoltaic energy", 3.4.28a).

3.4.68 power efficiency

see "efficiency/power efficiency", 3.4.26l).

3.4.69 rated

assigned quantity used for specification purposes indicating a specific characteristic of a PV system or component established for a specified set of operating conditions

NOTE 1 See also IEV 151-16-08.

a) **rated capacity**

   see "capacity/rated capacity", 3.4.10d).

b) **rated condition**

   conditions under which a manufacturer states a specific operating characteristic of a product

c) **rated current**

   (Symbol: I_R) (Unit: A)

   electric current produced by a PV device at a rated voltage under specified operating conditions

d) **rated efficiency**

   (Unit: dimensionless, usually expressed as a percentage, %)

   efficiency of a component at specified operating conditions

e) **rated load**

   electric load required to achieve the rated output power of a PV system or its PV devices, or components

f) **rated power**

   (Symbol: P_R) (Unit: W)

   electric power produced by a PV device or other PV system component under specified operating conditions

g) **rated power at STC**

   (Symbol: P_{stc}) (Unit: W)

   electric power delivered by a PV device at its maximum power point at standard test conditions, STC

   NOTE 2 Rated power at STC is colloquially, but incorrectly referred to as "peak power".

   NOTE 3 See also "conditions/standard test conditions", 3.4.16e).

h) **rated power at SOC**

   (Symbol: P_{soc}) (Unit: W)

   electric power delivered by a PV device or system under standard operating conditions

i) **rated sun-hours**

   (Unit: h)

   amount of time that the solar irradiance is at reference levels

   NOTE 4 Rated sun-hours is usually expressed on a daily basis.

   NOTE 5 If $G_{I,ref}$ = 1 kW·m^{-2} then "rated sun-hours" over any period of time is numerically equal to the irradiation over the same period as expressed in kWh·m^{-2}.

j) **rated system power**

   Pertaining to stand-alone PV systems: system power generated when connected to a rated load

Pertaining to grid-connected PV systems: system power that can be generated under standard operating conditions, SOC

NOTE 6 See also "conditions/standard operating conditions", 3.4.16d).

k) rated voltage

(Symbol: V_R) (Unit: V)

voltage at which a generator is designed to generate maximum electricity under specified operating conditions

3.4.70 **reference yield**

see "yield/reference yield", 3.4.96d).

3.4.71 **relative spectral response**

see "spectral response/relative spectral response", 3.4.82b).

3.4.72 **relative spectral response under load**

see "spectral response/relative spectral response under load", 3.4.82c).

3.4.73 **residual capacity**

see "capacity/residual capacity", 3.4.10e).

3.4.74 **reverse power flow**

electric power flow from a generating system into utility distribution grid

NOTE Reverse power flow is known as "backfeed". See "operation/backfeed operation", 3.3.52b).

3.4.75 **safe extra low voltage**

(Abbreviation: SELV) (Unit: V)

term defined by IEC Technical Committee 64 to be a safe low voltage

NOTE For DC systems, SELV is 130 V and below.

3.4.76 **self-discharge**

loss of useful capacity of an electrical storage device due to internal chemical action

3.4.77 **series resistance**

(Unit: Ω)

resistance in series with an ideal PV cell that results in ohmic voltage drop within the actual cell

3.4.78 **shadow cover rate**

(Symbol: s_A) (Unit: dimensionless, usually expressed as a percentage, %)

ratio of the equivalent area of the shaded portion of a PV array surface (A_s) to the overall PV array area (A)

It is calculated by:

$$s_A = A_s / A$$

where

s_A is the shadow cover rate;

A_s is the equivalent area of the part covered by shadow (m^2);

A is the overall PV array area (m^2).

NOTE The stated "equivalent area" is the assumed shadow area estimated including the influence of the shadow on the illuminated area through PV modules connected in series or in parallel.

3.4.79 **sheet resistance**

(Unit: Ω ("Ohms per square"))

electrical resistance of a thin film material measured across the opposite sides of a square area

3.4.80 **short-circuit current**

(Symbol: I_{SC}) (Unit: A)

electric current at the output terminals of a PV device at a particular temperature and irradiance when the device output voltage is equal to or close to zero

NOTE 1 See also IEV 195-05-18.

a) **short-circuit current under standard test conditions**

(Symbol: $I_{SC\ STC}$)

short-circuit electric current as measured under standard test conditions, STC

NOTE 2 See also "conditions/standard test conditions", 3.4.16e).

3.4.81 **shunt resistance**

(Unit: Ω)

resistance in parallel with an ideal PV cell that represents in electric current leakage losses within the actual cell

3.4.82 **spectral responsivity**

(Symbol: $S(\lambda)$) (Unit: $A \cdot W^{-1}$)

short-circuit electric current density generated by unit irradiance at a particular wavelength, plotted as a function of wavelength

NOTE 1 The term "response" instead of responsivity is commonly and colloquially used.

NOTE 2 For thin-film PV devices, the spectral response measurement must be done under the voltage that is appropriate to the intended use of the spectral response data. This voltage condition therefore is to be specified with the data.

a) **spectral response mismatch error**

error introduced in the testing of a PV device caused by the interaction of the mismatch between the spectral responses of the test specimen and the reference device, and the mismatch between the test spectrum and the reference spectrum

b) **relative spectral response**

(Symbol: $S(\lambda)_{rel}$) (Unit: dimensionless) spectral response normalised to unity at wavelength of maximum response

It is calculated by:

$$S(\lambda)_{rel} = S(\lambda) / S(\lambda)_{max}$$

c) **relative spectral response under load**

(Symbol: $S_V(\lambda)_{rel}$) (Unit: dimensionless)

spectral response under load normalised to unity at wavelength of maximum response

It is calculated by:

$$S_V(\lambda)_{rel} = S_V(\lambda) / S_V(\lambda)_{max}$$

d) **spectral response under load**

(Symbol: $S_{v\lambda}$)

electric current density at a particular load voltage, generated by unit irradiance at a particular wavelength, plotted as a function of wavelength

3.4.83 standard operating conditions

see "conditions/standard operating conditions", 3.4.16d).

3.4.84 standard test conditions

see "conditions/standard test conditions", 3.4.16e).

3.4.85 standby loss

(Unit: W)

Pertaining to stand-alone power conditioners: DC input power drawn by a power conditioner when it is in standby mode

Pertaining to grid-connected power conditioners: power drawn from the utility grid by a power conditioner when it is in standby mode

3.4.86 state of charge

(Unit: dimensionless, usually expressed as a percentage, %)

ratio between the residual capacity and the rated capacity of a storage device

a) **partial state of charge**

(Abbreviation: PSOC) (Unit: dimensionless, usually expressed as a percentage, %)

state indicating that an electrical storage device has not reached a fully charged condition

3.4.87 system efficiency

see "efficiency/system efficiency", 3.4.26n).

3.4.88 system output energy

(Unit: J, though usually expressed as kWh)

output energy of a system produced during a specified period of time

3.4.89 **system power**

see "rated/rated system power", 3.4.69j).

3.4.90 **test conditions**

see "conditions/test conditions", 3.4.16f).

3.4.91 **total harmonic distortion**

(Abbreviation: THD) (Unit: dimensionless, usually expressed as a percentage, %)

ratio of the r.m.s. value of the total harmonic content of a waveform to the r.m.s. value of the basic frequency of the waveform

NOTE See also IEV 551-17-06.

3.4.92 **voltage-irradiance coefficient**

see "coefficient/voltage-irradiance coefficient", 3.4.14b).

3.4.93 **voltage-temperature coefficient**

see "coefficient/voltage-temperature coefficient", 3.4.14c).

3.4.94 **watt-hour efficiency**

see "efficiency/watt-hour efficiency", 3.4.26p).

3.4.95 **weighted average conversion efficiency**

see "efficiency/weighted average conversion efficiency", 3.4.26q).

3.4.96 **yield**

(Unit: J·kW^{-1}. Usually expressed as kWh·kW^{-1} over any convenient unit of time. It is commonly calculated over a day, which then gives a unit of h·d^{-1}.)

duration that a PV device would need to operate at its rated power in order to generate the same amount of energy that it actually did generate

NOTE 1 A yield indicates actual device operation relative to its rated capacity.

NOTE 2 A yield is calculated from the ratio of the energy generated to the rated device power.

NOTE 3 Since yields can be calculated over any time period, the time interval in which they are being referenced is always specified as per IEC 61724.

a) **array yield**

(Symbol: Y_A)

PV array energy generated per unit of rated PV array capacity

b) **final annual yield**

total PV energy delivered to the load during one year per unit of rated PV array capacity

c) **final system yield**

(Symbol: Y_f)

portion of the net energy generated by the electric generating system that was supplied by the PV array per unit of rated array capacity

d) **reference yield**

(Symbol: Y_r)

duration that the irradiance would need to be at reference irradiance levels to contribute the same incident irradiation as actually occurred

It is calculated from the ratio of the total irradiation to the reference irradiance $G_{I,ref}$.

NOTE 4 If $G_{I,ref}$ = 1 kW·m^{-2} then the irradiation as expressed in kWh·m^{-2} over any period of time is numerically equal to energy as expressed in kWh·kW^{-1} over that same period. Thus Y_r would be, in effect, rated sun-hours over that same period.

3.5 Measurement devices

3.5.1 absolute radiometer

see "radiometer/absolute radiometer", 3.5.7a).

3.5.2 monochromatic light source

light source having a narrow bandwidth

NOTE For spectral response measurements, a 1 000 W tungsten halogen lamp operated from a stable power supply at a colour temperature of 3 200 K is commonly used.

3.5.3 photovoltaic array simulator

simulator that has I-V characteristics equivalent to an PV array

3.5.4 pulse type solar simulator

see "solar simulator/pulse type solar simulator", 3.5.8b)

3.5.5 pyranometer

see "radiometer/pyranometer", 3.5.7b).

3.5.6 pyrheliometer

see "radiometer/pyrheliometer", 3.5.7c).

3.5.7 radiometer

instrument for measuring the intensity of solar irradiance

NOTE 1 See also IEV 845-05-06.

NOTE 2 Commonly, a radiometer is a thermal instrument using thermocouples or thermopiles and is independent of wavelength.

a) **absolute radiometer**

radiometer that can measure or calculate the absolute quantity of radiant power based on physical laws and the known physical constants of its components

b) **pyranometer**

radiometer normally used to measure global irradiance on a horizontal plane

NOTE 3 A pyranometer can also be used to measure diffuse irradiance when used with a shade ring or disc.

NOTE 4 A pyranometer can also be used to measure total irradiance on an inclined plane, which would include radiation reflected from the foreground.

c) **pyrheliometer**

radiometer, including with a collimator, used to measure direct irradiance

NOTE 5 A pyrheliometer is sometimes called a normal incidence pyrheliometer, or NIP.

d) **spectroradiometer**

instrument used to measure spectral irradiance distribution of an incident radiation as the function of wavelength

3.5.8 solar simulator

equipment employing a standard light source with a spectral irradiance distribution similar to the natural sunlight used to evaluate characteristics of PV cells and modules

a) **solar simulator class**

rating method based on simulator performance for spectral irradiance match, non-uniformity and temporal simulator instability

NOTE Three classes of solar simulators are defined, class A, B and C, with A being the best.

b) **pulse type solar simulator**

flashed light source consisting of one or more long-arc xenon lamps capable of irradiating large areas uniformly with little heat input to the PV cell or module being tested

c) **steady-state type solar simulator**

continuous light source frequently employing filtered xenon, dichroic filtered tungsten or modified mercury vapour with tungsten electrodes as the light source;

3.5.9 spectroradiometer

see "radiometer/spectroradiometer", 3.5.7d).

3.5.10 steady-state type solar simulator

see "solar simulator/steady-state type solar simulator", 3.5.8c).

3.5.11 temporal simulator instability

(Unit: dimensionless, usually expressed as a percentage, %)

time-based uniformity of solar simulator irradiance at a given point on the PV module or simulator test plane during the period of data acquisition

NOTE Temporal simulator instability is the difference in maximum irradiance minus the minimum irradiance during the data acquisition period, divided by the sum of the same maximum irradiance and the minimum irradiance.

3.6 Environmental parameters

3.6.1 air mass index

(Abbreviation: AM) (Unit: dimensionless)

length of path through the earth's atmosphere traversed by the direct solar beam, expressed as a multiple of the path traversed to a point at sea level with the sun directly overhead

NOTE The air mass index is 1,0 at sea level with cloudless sky when the sun is directly overhead and the local air pressure equals P0. Standard operating conditions, 3.4.16d), and standard test conditions, 3.4.16e), use an AM of 1,5.

3.6.2 albedo

(Unit: dimensionless, usually expressed as a percentage, %)

ratio of radiation averaged over all the wavelengths reflected by a surface to that incident on it

NOTE The albedo term compares the reflectance of a ground surface to solar radiation

3.6.3 ambient temperature

(Symbol: T_{amb}) (Unit: °C)

average temperature of the air surrounding a PV device

[IEV 826-10-03]

3.6.4 angle

(Unit: degree or radian)

a) **angle of incidence**

angle between the direct irradiant beam and the normal to the active surface

b) **aperture angle**

subtended half angle of the aperture of the cylinder in the centre of a detector

NOTE 1 A full angle is used occasionally instead of a half angle.

c) **azimuth angle**

(Symbol: α)

projected angle between a straight line from the apparent position of the sun to the point of observation and a horizontal line normal to the equator

NOTE 2 Azimuth angle is measured from due north in the southern hemisphere and from due south in the northern hemisphere.

NOTE 3 Negative azimuth values indicate an eastern orientation and positive values, a western orientation.

d) **solar elevation angle**

(Symbol: θ)

angle between the direct solar beam and the horizontal plane

e) **tilt angle**

angle between the horizontal plane and the plane of the PV module surface

3.6.5 annealing conditioning

see "conditioning/annealing conditioning", 3.6.9a).

3.6.6 aperture angle

see "angle/aperture angle", 3.6.4b).

3.6.7 atmospheric

a) **atmospheric ozone content**

(Unit: cm of column height)

volume of ozone at standard temperature and pressure in a vertical column of the atmosphere 1 cm^2 in cross section

b) **precipitable water vapour content**

(Unit: cm of column height)

volume of precipitable water vapour in a vertical column of the atmosphere 1 cm^2 in cross section

c) **atmospheric transmissivity**

(Unit: dimensionless, usually expressed as a percentage, %)

ratio of the transmission light intensity against the incident light intensity when measured with the unit length of the perpendicular column of the atmosphere

3.6.8 **azimuth angle**

see "angle/azimuth angle", 3.6.4c).

3.6.9 **conditioning**

process for stabilizing the performance of a PV module prior to conducting an environmental test

NOTE 1 Conditioning is sometimes referred to as *pre-conditioning*.

NOTE 2 Conditioning enables the effect of an environmental test to be determined without an extraneous shift in performance from an effect other than the specific environmental exposure.

Generally, the conditioning is one of the following:

a) **annealing conditioning**

conditioning using a heat exposure process

b) **light soaking conditioning**

conditioning using a light exposure process

3.6.10 **damp heat test**

see "environmental test/damp heat test", 3.6.15a).

3.6.11 **diffuse irradiance**

see "irradiance/diffuse irradiance", 3.6.25a).

3.6.12 **diffuse irradiation**

see "irradiation/diffuse irradiation", 3.6.26a).

3.6.13 **direct irradiance**

see "irradiance/direct irradiance", 3.6.25b).

3.6.14 **direct irradiation**

see "irradiation/direct irradiation", 3.6.26b).

3.6.15 **environmental test**

test in which a product is exposed to simulated environmental conditions such as temperature, wind, rain, snow, hail or humidity

NOTE During an environmental test, simulated environmental conditions are frequently more extreme than normal environmental conditions, as a means of accelerating any degradation processes.

The environmental tests currently in use for PV modules include:

a) **damp heat test**

   environmental test intended to determine the ability of a PV module to withstand the effects of long-term penetration of humidity

b) **hail test**

   environmental test intended to verify that a PV module is capable of withstanding the impact of hailstones

c) **hot-spot endurance test**

   environmental test intended to determine the ability of a PV module to withstand hot-spot heating effects, e.g., solder melting or deterioration of the encapsulation

d) **humidity freeze test**

   environmental test intended to determine the ability of a PV module to withstand the effects of high temperature and humidity followed by sub-zero temperature

e) **impact test**

   environmental test intended to assess the susceptibility of a PV module to accidental impact damage

f) **insulation test**

   environmental test intended to determine whether or not a PV module is sufficiently well insulated between electric current carrying parts and the frame

g) **mechanical load test**

   environmental test intended to determine the ability of a PV module to withstand wind, snow, static, or ice loads

h) **outdoor exposure test**

   environmental test intended to make a preliminary assessment of the ability of a PV module to withstand exposure to outdoor conditions and to reveal any synergistic degradation effects that may not be detected by laboratory tests

i) **robustness of terminations test**

   environmental test intended to determine that the terminations and the attachment of the termination to the body of a PV module will withstand such stresses as are likely to be applied during normal assembly or handling operations

j) **salt mist test**

   environmental test intended to determine the resistance of a PV module to corrosion from salt mist in order to evaluate the compatibility of materials and the quality and uniformity of protective coatings

k) **thermal cycling test**

   environmental test intended to determine the ability of a PV module to withstand thermal mismatch, fatigue and other stresses caused by repeated changes of temperature

l) **twist test**

   environmental test intended to detect defects that might arise in a PV module when mounted on an imperfect structure

m) **UV test**

   environmental test intended to determine the ability of a PV module to withstand exposure to ultraviolet radiation (UV)

n) **wet leakage current test**

environmental test intended to evaluate the insulation of a PV module under wet operating conditions and verify that moisture from rain, fog, dew or melted snow does not enter the active parts of the module circuitry, where it might cause corrosion, ground leakage, or a safety hazard

3.6.16 **global irradiance**

see "irradiance/global irradiance", 3.6.25c).

3.6.17 **global irradiation**

see "irradiation/global irradiation", 3.6.26c).

3.6.18 **hail test**

see "environmental test/hail test", 3.6.15b).

3.6.19 **hot-spot endurance test**

see "environmental test/hot-spot endurance test", 3.6.15c).

3.6.20 **humidity freeze test**

see "environmental test/humidity freeze test", 3.6.15d).

3.6.21 **impact test**

see "environmental test/impact test", 3.6.15e).

3.6.22 **in-plane irradiance**

see "irradiance/in-plane irradiance", 3.6.25d).

3.6.23 **insulation test**

see "environmental test/insulation test", 3.6.15f).

3.6.24 **integrated irradiance**

see "irradiance/integrated irradiance", 3.6.25e).

3.6.25 **irradiance**

(Symbol: G) (Unit: $W \cdot m^{-2}$)

electromagnetic radiated power per unit of area

NOTE 1 Irradiance commonly references light from the sunsolar simulator.

a) **diffuse irradiance**

irradiance excluding that portion which contributes to direct irradiance

b) **direct irradiance**

irradiance from the sun's disk and from the circumsolar region of the sky within a subtended angle of $8,7 \times 10^{-2}$ radian (5°)

c) **global irradiance**

irradiance on a horizontal surface

NOTE 2 Global irradiance equals horizontal direct irradiance plus horizontal diffuse irradiance.

d) **in-plane irradiance**

(Symbol: G_{I})

total irradiance on the plane of a PV device

e) **integrated irradiance**

continuously integrated spectral irradiance over the total range of wavelengths

NOTE 3 If the spectral range is limited, the range is to be stated. If not, then the irradiance is integrated over the total or almost total range of wavelengths.

NOTE 4 Integrated irradiance is measured by a pyranometer that can precisely respond to the spectral profile of the radiation.

f) **plane of array irradiance**

same as in-plane irradiance

g) **spectral irradiance**

(Symbol: E_{λ}) (Unit: $\text{W}\cdot\text{m}^{-2}\cdot\mu\text{m}^{-1}$)

irradiance per unit bandwidth at a particular wavelength

h) **spectral photon irradiance**

(Symbol: $E_{\text{p}\lambda}$) (Unit: $\text{cm}^{-2}\cdot\text{s}^{-1}\cdot\mu\text{m}^{-1}$)

photon flux density at a particular wavelength $E_{\text{p}\lambda} = 5{,}035 \times 10^{14}\cdot\lambda\cdot E_{\lambda}$, where λ is in µm

i) **test irradiance**

(Symbol: G_{t})

irradiance used for test purposes, as measured with a reference PV device

j) **total irradiance**

(Symbol: G_{T})

direct plus diffuse irradiance on an inclined surface

3.6.26 **irradiation**

(Symbol: H) (Unit: $\text{J}\cdot\text{m}^{-2}$)

irradiance integrated over a specified time interval

a) **diffuse irradiation**

diffuse irradiance integrated over a specified time interval

b) **direct irradiation**

direct irradiance integrated over a specified time interval

c) **global irradiation**

global irradiance integrated over a specified time interval

d) **total irradiation**

(Symbol: H_{T})

total irradiance integrated over a specified time interval

3.6.27 **light soaking conditioning**

see "conditioning/light soaking conditioning", 3.6.9b).

3.6.28 **mechanical load test**

see "environmental test/mechanical load test", 3.6.15g).

3.6.29 **outdoor exposure test**

see "environmental test/outdoor exposure test", 3.6.15h).

3.6.30 **ozone content**

see "atmospheric/atmospheric ozone content", 3.6.7a).

3.6.31 **plane of array irradiance**

see "irradiance/plane of array irradiance", 3.6.25f).

3.6.32 **precipitable water vapour content**

see "atmospheric/precipitable water vapour content", 3.6.7b).

3.6.33 **reference spectral irradiance distribution**

see "spectral irradiance distribution/reference spectral irradiance distribution", 3.6.37a).

3.6.34 **robustness of terminations test**

see "environmental test/robustness of terminations test", 3.6.15i).

3.6.35 **salt mist test**

see "environmental test/salt mist test", 3.6.15j).

3.6.36 **spectral irradiance**

see "irradiance/spectral irradiance", 3.6.25g).

3.6.37 **spectral irradiance distribution**

(Unit: $W \cdot m^{-2} \cdot \mu m^{-1}$)

spectral irradiance plotted as a function of wavelength

a) **reference spectral irradiance distribution**
   tabulation of spectral irradiance, spectral photon irradiance and cumulative integrated irradiance versus wavelength, as defined in Table 1 of IEC 60904-3:1989

3.6.38 **spectral photon irradiance**

see "irradiance/spectral photon irradiance", 3.6.25h).

3.6.39 **spectrum**

see "solar/solar spectrum", 3.6.40e).

3.6.40 **solar**

of or pertaining to matters relating to the sun or its irradiance

a) **solar constant**
   (Unit: $W \cdot m^{-2}$)
   irradiance produced by extraterrestrial solar radiation on a surface normal to this radiation at the mean Sun-Earth distance

[IEV 845-09-78, modified]

NOTE The latest value for the solar constant is 1 367 W·m^{-2} adopted by the Commission for Instruments and Methods of Observation in World Meteorological Organization in 1981.

b) solar energy

common term meaning irradiation

c) solar power

common term meaning irradiance

d) solar radiation

common term meaning irradiation

e) solar spectrum

(Unit: J·m^{-2}·µm^{-1})

distribution of the solar irradiation as the function of wavelength

3.6.41 **solar elevation angle**

see "angle/solar elevation angle", 3.6.4d).

3.6.42 **test irradiance**

see "irradiance/test irradiance", 3.6.25i).

3.6.43 **thermal cycling test**

see "environmental test/thermal cycling test", 3.6.15k).

3.6.44 **tilt angle**

see "angle/tilt angle", 3.6.4e).

3.6.45 **total irradiance**

see "irradiance/total irradiance", 3.6.25j).

3.6.46 **total irradiation**

see "irradiation/total irradiation", 3.6.26d).

3.6.47 **transmissivity**

see "atmospheric/atmospheric transmissivity", 3.6.7c).

3.6.48 **turbidity**

(Symbol: $a_{D,\ \lambda}$) (Unit: µm)

reduced transparency of the atmosphere, caused by absorption and scattering of radiation by solid or liquid particles, other than clouds, held in suspension

3.6.49 **twist test**

see "environmental test/twist test", 3.6.15l).

3.6.50 **UV test**

see "environmental test/UV test", 3.6.15m).

3.6.51 **wet leakage current test**

see "environmental test/wet leakage current test", 3.6.15n).

3.6.52 **white bias light**

continuous white light illuminating a PV device simultaneously with chopped monochromatic light to make the device operate in a normal working condition when spectral irradiance distribution is measured

3.7 Quality and testing

3.7.1 **acceptance tests**

contractual test to prove to the customer that the item meets certain conditions of its specification

[IEV 151-16-23]

3.7.2 **applicant**

an organisation that has applied for participation in a certification programme

3.7.3 **calibration**

set of operations which establishes, by reference to standards, the relationship which exists, under specified conditions, between an indication and a result of a measurement

[IEV 311-01-09]

3.7.4 **cell manufacturer**

see "manufacturer/cell manufacturer", 3.7.14a).

3.7.5 **certificate of conformity**

tag, label, nameplate, or document of specified form and content, affixed or otherwise directly associated with a product or service on delivery to the buyer, attesting that the product or service is in conformity with the requirements of an associated certification programme

3.7.6 **certification**

procedure by which written assurance is given that a product or service conforms to a specification

a) **certification body**

impartial body, or organization, possessing the necessary competence to develop, promulgate, finance, and operate a certification programme, and to conduct certifications of conformity

b) **certification mark**

sign, or symbol, owned and controlled by the certification body that is used exclusively by the third-party certification programme to identify products or services as being certified

c) **certification programme**

system that relates to specific products, processes or services to which the same particular standards and rules, and the same procedure, apply

NOTE A certification programme uses or is operated by a third-party inspection/testing body, or organization, and the programme authorises the use of controlled certification marks or certificates of conformity as evidence of conformity.

d) **third-party certification**

certification that is rendered by a technically and otherwise competent body other than one controlled by the producer or the buyer

3.7.7 **certified reference photovoltaic material**

(Abbreviation: CRM)

reference PV material, one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying body

NOTE A standard reference PV cell is an example of a CRM.

3.7.8 **conformity**

fulfilment of specified requirements by a product, process, or service to determine if a product remains as intended

a) **conformity evaluation**

systematic examination of the extent to which a product, process or service fulfils specified requirements

NOTE 1 Conformity evaluation is also known as Conformity Assessment.

NOTE 2 Conformity Assessment is necessary to assure that a quality system is in place that assures that the product or system configuration does not change from that which was tested.

b) **conformity surveillance**

evaluation for conformity to determine the continuing conformity with specified requirements

3.7.9 **inspection**

evaluation for conformity by measuring, observing, testing, or gauging the relevant characteristics as required by a specification or standard

a) **inspection body**

inspection body is an organization that may be organized as a part of a testing laboratory and/or functional arm of the certification body that performs initial inspections of a manufacturer's or producer's operations, including any subsequent surveillance procedures that may be required

b) **inspection body (third-party)**

inspection organization that possesses the necessary technical competence to perform initial inspections and/or audits and subsequent follow-up inspections and/or audits, and is other than one operated or controlled by a manufacturer, supplier, or buyer (user) of a certified product or service in that it has no organizational, financial, or commercial involvement with the producer or buyer that might pose a potential conflict of interest

NOTE An inspection body may be the functional arm of a certification body.

3.7.10 **interlaboratory testing**

organization, performance and evaluation of tests on the same or similar items or materials by two or more laboratories in accordance with predetermined conditions

3.7.11 **laboratory**

a) **testing laboratory**

body, or organization, that performs tests and provides a formal, written report of the results

NOTE In cases where the laboratory forms part of an organization that carries out activities in addition to testing and calibration, the term "laboratory" refers only to that part of the organization that actually performs the testing of PV modules, components and complete systems.

b) **testing laboratory (third-party)**

testing body laboratory that possesses the necessary technical competence to perform the required tests, and is other than one operated or controlled by a manufacturer, supplier, or buyer (user) of a certified product or service in that it has no organizational, financial, or commercial involvement with the producer or buyer that might pose a potential conflict of interest

3.7.12 **licensee (for certification)**

person, manufacturer or producer to which a certification body has granted a license

3.7.13 **license for certification**

document, issued under the rules of a certification programme, by which a certification body grants to a person, manufacturer or producer, the right to use the certificates or marks of conformity for its products, processes or services in accordance with the rules of the relevant certification programme

3.7.14 **manufacturer**

organisation carrying out a manufacturing step in the process of the production of a product

a) **cell manufacturer**

organisation carrying out the manufacture of PV cells

b) **module manufacturer**

organisation carrying out the encapsulation function in the process of the production of PV modules

3.7.15 **memorandum of understanding**

(Abbreviation: MOU)

agreement to cooperate and abide by the rules established by one or more parties to the agreement

3.7.16 **module manufacturer**

see "manufacturer/module manufacturer", 3.7.14b).

3.7.17 **participant**

an organisation that is participating in a certification programme

3.7.18 **photovoltaic elements/equipment**

(Abbreviation: PVE)

collectively describes PV modules, systems, and system components such as charge regulators, inverters, energy storage devices, etc.

3.7.19 **proficiency testing**

regular, periodic determination of the laboratory testing or calibration performance of unknowns usually by means of interlaboratory comparisons

3.7.20 **qualification test**

test performed on a randomly selected set of component or complete system samples for the purpose of verifying the acceptability of the basic design

NOTE 1 Qualification tests may be for environmental durability, performance or safety verification.

NOTE 2 The qualification test procedures may involve performance measurements and/or the application of defined electrical, mechanical, or thermal stresses in a prescribed manner and amount.

NOTE 3 The results of qualification tests are subject to a list of defined requirements.

3.7.21 **quality manual**

document stating the quality policy, or policies, and the quality system and quality practices of an organization

3.7.22 **quality system**

organizational structure, responsibilities, procedures, processes and resources for implementing quality management

3.7.23 **reference material**

physical material, or substance, one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials

3.7.24 **reference standard**

physical standard, generally of the highest metrological quality available to the test laboratory, from which measurements made at that location are derived

3.7.25 **standard**

prescribed set of conditions and requirements, established by authority or agreement, for continuous application

NOTE 1 The standard takes the form of a document containing a set of conditions to be fulfilled, or an object of comparison.

NOTE 2 For the purposes of the standard, the provisions as defined and used in it are suitable to and capable of certification.

3.7.26 **system producer**

system designer, fabricator and/or assembler providing the complete system service to be purchased and employed by a user

NOTE The system producer is responsible for assuring conformity with all of the system requirements of the certification programme.

3.7.27 **test and calibration procedures manual**

written document, or documents that contain the specific instructions, preferably in active voice and imperative mood, for carrying out tests or calibrations

3.7.28 **testing**

actions, or the process, of carrying out one or more tests

3.7.29 **testing laboratory**

see "laboratory/testing laboratory", 3.7.11a).

3.7.30 **testing laboratory (third-party)**

see "laboratory/testing laboratory (third-party)", 3.7.11b).

3.7.31 **test method**

documented technical procedure for performing a test

NOTE The test method may be called out in either internal documentation, or, whenever possible, in a published consensus standard.

3.7.32 **test**

technical operation that consists of the determination of one or more characteristics of a given product, process or service according to a specified procedure

[IEV 151-16-13]

NOTE A test is carried out to measure or classify a characteristic or a property of an item by applying to the item a set of environmental and operating conditions and/or requirements.

3.7.33 **test sequence**

set of one or more Qualification Tests applied in a specified order to a selected group of PV modules, components, and complete systems

3.7.34 **third-party certification**

see "certification/third-party certification", 3.7.6d).

3.7.35 **traceability**

property of a result of measurements whereby it can be related to appropriate physical standards maintained by an appropriate international standards body, through an unbroken chain of comparisons

3.7.36 **type approval**

approval of a product or system type based on the successful completion of a conformity assessment and the required qualification tests

3.7.37 **type test**

test of one or more devices made to a certain design to show that the design meets certain specifications

3.7.38 **uniformity**

product has not changed from the standards