

TECHNICAL SPECIFICATION

Solar photovoltaic energy systems – Terms, definitions and symbols

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TECHNICAL SPECIFICATION

Solar photovoltaic energy systems – Terms, definitions and symbols

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**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 by IEC technical committee 82: Solar photovoltaic energy systems.

This third edition cancels and replaces the second edition published in 2007. This edition constitutes a technical revision.

The main technical change with regard to the previous edition consists of adding / revising terms and definitions which have been discussed and agreed on during recent TC 82 WG 1 meetings, more particularly at the WG 1 meeting in Pretoria in 2015-11.

The changes made in this new edition were kept limited deliberately, in order to avoid a long development process and get the newest terms and definitions published as promptly as possible, so that they can be used in the market place.

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

Enquiry draft	Report on voting
82/1117/DTS	82/1176/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 document 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 stability date indicated on the IEC website 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- withdrawn,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 is 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 in any convenient unit of time that the user may wish, such as day, month or year.

NOTE 8 " W_p " is not 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:

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SOLAR PHOTOVOLTAIC ENERGY SYSTEMS – TERMS, DEFINITIONS AND SYMBOLS

1 Scope

This Technical Specification deals with the terms, definitions 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, definitions and symbols compiled from the published IEC technical committee 82 standards.

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

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60904-3:2016, *Photovoltaic devices – Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data*

3 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 3.2. Photovoltaic systems are described in 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", 3.1.67.1

3.1.3

anti-reflective coating

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

3.1.4 Area

3.1.4.1

active cell area

part of the total cell area designed to receive solar radiation for creating the photovoltaic effect

Note 1 to entry: Active cell area equals the total cell area minus the area contribution of the metallisation lines if any.

3.1.4.2**active module area**

sum of total cell areas of all the cells in the module

3.1.4.3**cell aperture area**

area that is smaller than the total cell area and bounded by an opaque mask

3.1.4.4**module aperture area**

area that is smaller than the total module area and bounded by an opaque mask or frame

3.1.5**back surface field effect**

SEE: "effect/back surface field effect", 3.1.28.1

3.1.6**band gap energy**

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

Note 1 to entry: Unit: eV.

3.1.7**barrier energy**

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

Note 1 to entry: The barrier energy is a measure of the electrostatic potential of the barrier.

Note 2 to entry: Unit: eV.

3.1.8**building-attached photovoltaic module**

photovoltaic module that is designed to be fastened onto building construction materials

Note 1 to entry: Building-attached photovoltaic modules do not form part of the construction materials.

3.1.9**building-integrated photovoltaic module**

photovoltaic module that provides one or more required functions of the building envelope

Note 1 to entry: When a building-integrated photovoltaic module is removed, it leaves something out of the building envelope that must be repaired.

3.1.10**bus lines**

SEE: "metallisation line/bus bar", 3.1.42.1

3.1.11**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

3.1.12**cell**

SEE: "photovoltaic/photovoltaic cell", 3.1.48.1

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

3.1.12.1

CIS photovoltaic cell

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

3.1.12.2

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/CuInSe₂, etc.

3.1.12.3

concentrator photovoltaic cell

SEE: "concentrator photovoltaic cell", 3.8.5.1

3.1.12.4

dye-sensitized photovoltaic cell

photoelectrochemical device using dye molecules with two electrodes and an electrolyte

3.1.12.5

integrated type photovoltaic cell

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

Note 1 to entry: Integrated type PV cells may include stacked or side-by-side configurations.

3.1.12.6

multijunction 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

3.1.12.7

organic photovoltaic cell

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

3.1.12.8

PN junction photovoltaic cell

PV cell using a PN junction

Note 1 to entry: See also "PN junction", 3.1.39.6.

3.1.12.9

Schottky barrier photovoltaic cell

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

3.1.12.10

silicon photovoltaic cell

PV cell fabricated of silicon material as a main constituent

3.1.12.11

stacked photovoltaic cell

SEE: "cell/multijunction photovoltaic cell", 3.1.12.6

3.1.12.12

tandem photovoltaic cell

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

SEE: "cell/multijunction photovoltaic cell", 3.1.12.6

3.1.12.13**thin film photovoltaic cell**

PV cell made of thin layers of semiconductor material

Note 1 to entry: See also "silicon/polycrystalline silicon", 3.1.67.5.

3.1.13**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 to entry: A cell barrier is also known as the "depletion zone".

Note 2 to entry: An electric-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.

3.1.14**cell junction**

SEE: "junction/cell junction", 3.1.39.1

3.1.15**CIS photovoltaic cell**

SEE: "cell/CIS photovoltaic cell", 3.1.12.1

3.1.16**compound semiconductor photovoltaic cell**

SEE: "cell/compound semiconductor photovoltaic cell", 3.1.12.2

3.1.17**conversion efficiency**

ratio of electric power generated by a PV device per unit area to its incident irradiance

Note 1 to entry: Typically measured under standard test conditions, STC. See also "conditions/standard test conditions", 3.4.16.5.

Note 2 to entry: Unit: dimensionless, usually expressed as a percentage, %.

3.1.18**crystalline silicon**

SEE: "silicon/crystalline silicon", 3.1.67.2

3.1.19**current**

for PV devices and related entries, see "photovoltaic/photovoltaic current", 3.1.48.2

Note 1 to entry: There are many uses for the electrical term "current".

3.1.20**Czochralski process**

SEE: "ingot manufacturing process/Czochralski process", 3.1.37.1

3.1.21**dark current**

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

Note 1 to entry: Unit: A.

3.1.22**device**

SEE: "photovoltaic/photovoltaic device", 3.1.48.3

3.1.23

diffusion layer

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

3.1.24

directional solidification

SEE: "ingot manufacturing process/directional solidification", 3.1.37.2

3.1.25

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

3.1.26

dopant <in photovoltaic cells>

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

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

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

3.1.27

dye-sensitized photovoltaic cell

SEE: "cell/dye-sensitized photovoltaic cell", 3.1.12.4

3.1.28

effect

SEE: "photovoltaic/photovoltaic effect", 3.1.48.4

3.1.28.1

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

3.1.28.2

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.

3.1.29

electromagnetic casting

SEE: "ingot manufacturing process/electromagnetic casting", 3.1.37.3

3.1.30

encapsulant

material used between the substrate and superstrate to provide environmental protection for photovoltaic cells in a photovoltaic module

3.1.31

energy gap

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

Note 1 to entry: See also "band gap energy", 3.1.6.

Note 2 to entry: Unit: eV.

3.1.32**flexible photovoltaic module**

photovoltaic module that is designed to be intentionally and repetitively twisted, curved or otherwise bent without physical, electrical or visual damage

3.1.33**float zone melting**

SEE: "ingot manufacturing process/float zone melting", 3.1.37.4

3.1.34**grid lines**

SEE: "metallisation line/grid line", 3.1.42.2

3.1.35**heterojunction**

SEE: "junction/heterojunction", 3.1.39.2

3.1.36**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 1 to entry: 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.

3.1.37**ingot manufacturing process**

process by which an ingot is manufactured

3.1.37.1**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 to entry: The Czochralski process produces a cylindrical-section silicon ingot, which can be cut into wafers that are usually round or pseudo-square.

3.1.37.2**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 1 to entry: Directional solidification produces a square-section silicon ingot that can be cut into wafers that are square or rectangular.

3.1.37.3**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 1 to entry: Electromagnetic casting produces a square-section silicon ingot that can be cut into wafers that are square or rectangular.

3.1.37.4**float zone melting**

method of growing and purifying high quality single crystal ingots

3.1.38

integrated type photovoltaic cell

SEE: "cell/integrated type cell", 3.1.12.5

3.1.39

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

[SOURCE: IEC 60050-521:2002, 521-02-72]

3.1.39.1

cell junction

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

Note 1 to entry: The PV cell junction lies within the cell barrier or depletion zone.

3.1.39.2

heterojunction

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

3.1.39.3

homojunction

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

3.1.39.4

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

[SOURCE: IEC 60050-521:2002, 521-02-71]

3.1.39.5

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 1 to entry: A PIN junction is widely used in thin film amorphous silicon PV cells.

3.1.39.6

PN junction

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

3.1.40

light confinement effect

SEE: "effect/light-confinement effect", 3.1.28.2

3.1.41

material

SEE: "photovoltaic/photovoltaic material", 3.1.48.5

3.1.42

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 to entry: A metallisation line can be screen-printed, vapour-deposited or extruded (line-written).

Note 2 to entry: The lines are of two types.

3.1.42.1

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 1 to entry: Interconnect wires are connected to the bus bars by soldering or welding.

3.1.42.2

grid line

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

3.1.43

microcrystalline silicon

SEE: "silicon/microcrystalline silicon", 3.1.67.3

3.1.44

module

SEE: "photovoltaic/photovoltaic module", 3.1.48.6

3.1.45

multicrystalline silicon

SEE: "silicon/multicrystalline silicon", 3.1.67.4

3.1.46

multijunction photovoltaic cell

SEE: "cell/multijunction photovoltaic cell", 3.1.12.6

3.1.47

organic photovoltaic cell

SEE: "cell, organic photovoltaic cell", 3.1.12.7

3.1.48

photovoltaic photovoltaics PV

relating to electrical phenomena caused by the photovoltaic effect

3.1.48.1

photovoltaic cell

most elementary photovoltaic device

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

3.1.48.2

photovoltaic conversion

process of electric energy generation by the photovoltaic effect

Note 1 to entry: The most-common photovoltaic conversion is from solar irradiation to electric energy.

3.1.48.3

photovoltaic current

DC electric current generated in a photovoltaic device

Note 1 to entry: See also "dark current", 3.1.21.

Note 2 to entry: Unit: A.

3.1.48.4

photovoltaic device

component that exhibits the photovoltaic effect

Note 1 to entry: Examples of a photovoltaic device includes a photovoltaic cell, module or array.

3.1.48.5

photovoltaic effect

basic physical phenomenon in which an electric potential difference is produced by the absorption of photons

Note 1 to entry: 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.

3.1.48.6

photovoltaic material

material that exhibits the photovoltaic effect

3.1.48.7

photovoltaic module

complete and environmentally protected assembly of interconnected photovoltaic cells

Note 1 to entry: Photovoltaic modules can be assembled into photovoltaic panels and photovoltaic arrays. See "photovoltaic/photovoltaic panel" (3.3.59.5) and "photovoltaic/photovoltaic array" (3.3.59.1).

3.1.49

photovoltaic generator

power supply unit using the photovoltaic effect to convert solar irradiation into direct current electricity

Note 1 to entry: The main component of a photovoltaic generator is the photovoltaic array.

Note 2 to entry: A photovoltaic generator does not include energy storage devices or power conditioners.

3.1.50

photovoltaic laminate

portion of a photovoltaic module consisting of substrate, encapsulant, complete photovoltaic cell circuit, and superstrate

Note 1 to entry: A photovoltaic module includes a laminate and a junction box. A frame and other accessories can also be added.

3.1.51

photovoltaic lamination

process of bonding the substrate, encapsulant, complete photovoltaic cell circuit, and superstrate

3.1.52 Photovoltaic module

3.1.52.1

crystalline silicon photovoltaic module

c-Si photovoltaic module

module fabricated from crystalline silicon as the active photovoltaic materials

Note 1 to entry: This is a wafer-based technology.

Note 2 to entry: The crystalline structure can be in the form of monocrystalline (single-crystal, sc-Si), multicrystalline (mc-Si), etc.

Note 3 to entry: The semiconductor has a PN homojunction structure.

3.1.52.2**silicon heterojunction photovoltaic module****c-Si/a-Si heterojunction photovoltaic module**

module fabricated from crystalline silicon combined with amorphous silicon as the active photovoltaic materials

Note 1 to entry: This is a wafer-based technology.

Note 2 to entry: The semiconductor has a heterojunction structure.

3.1.52.3**thin-film amorphous silicon photovoltaic module****a-Si photovoltaic module****a-Si, a-Si:H**

module fabricated from hydrogenated amorphous silicon (a-Si:H) as the active photovoltaic material

Note 1 to entry: Also referenced as a thin-film amorphous silicon photovoltaic module.

Note 2 to entry: The semiconductor has a PIN structure.

Note 3 to entry: Variants of thin-film amorphous silicon include microcrystalline silicon ($\mu\text{-Si}$), etc.

3.1.52.4**thin-film cadmium telluride photovoltaic module****CdTe photovoltaic module****CdTe**

module fabricated from cadmium (Cd), tellurium (Te) and sulphur (S) as the active photovoltaic materials

Note 1 to entry: The semiconductor has a heterojunction structure with cadmium telluride (CdTe) and cadmium sulphide (CdS) or other material.

3.1.52.5**thin-film copper indium selenide photovoltaic module****CIS photovoltaic module****CIS**

module fabricated from copper (Cu), indium (In) and selenium (Se) as the active photovoltaic materials

Note 1 to entry: Also referenced as a thin-film CIS photovoltaic module.

Note 2 to entry: Other elements can be used, for example gallium (Ga) and sulphur (S) to make a copper (Cu) indium (In) gallium (Ga) and selenium (Se) cell (abbreviation CIGS).

Note 3 to entry: The semiconductor has an heterojunction structure with cadmium sulphide (CdS) or another material.

3.1.52.6**thin-film copper indium gallium selenide photovoltaic module****CIGS photovoltaic module**

see CIS photovoltaic module

3.1.53**PIN junction**

SEE: "junction/PIN junction", 3.1.39.5

3.1.54**PN junction**

SEE: "junction/PN junction", 3.1.39.6

3.1.55

PN junction photovoltaic cell

SEE: "cell/PN junction cell", 3.1.12.8

3.1.56

polycrystalline silicon

SEE: "silicon/polycrystalline silicon", 3.1.67.5

3.1.57

power

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

Note 1 to entry: Power is commonly but incorrectly used to mean "electricity" or "electrical".

Note 2 to entry: Unit: W.

3.1.58

primary reference photovoltaic cell

SEE: "reference photovoltaic cell/primary reference photovoltaic cell", 3.1.59.1

3.1.59

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

3.1.59.1

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)

3.1.59.2

secondary reference photovoltaic cell

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

3.1.60

reference photovoltaic device

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

3.1.61

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

3.1.62

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)

3.1.63

Schottky barrier photovoltaic cell

SEE: "cell/Schottky barrier photovoltaic cell", 3.1.12.9

3.1.64

Schottky junction

SEE: "junction, Schottky barrier", 3.1.39.4

3.1.65**secondary reference photovoltaic cell**

SEE: "reference photovoltaic cell/secondary reference photovoltaic cell", 3.1.59.2

3.1.66**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

Note 1 to entry: The term "semiconductor" generally applies where the charge carriers are electrons or holes.

Note 2 to entry: In order to increase the conductivity, the energy supplied must be greater than the band gap energy. See also "band gap energy", 3.1.6.

Note 3 to entry: 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.

[SOURCE: IEC 60050-121:1998, 121-12-06] [SOURCE: IEC 60050-521:2002, 521-02-01, modified]

3.1.67**silicon****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 to entry: Silicon crystallises in a face-centred cubic lattice like a diamond.

Note 2 to entry: The terms here are applied to materials, wafers, cells, and modules.

3.1.67.1**amorphous silicon****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

3.1.67.2**crystalline silicon****c-Si**

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

3.1.67.3**microcrystalline silicon** **$\mu\text{c-Si}$**

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

3.1.67.4**multicrystalline silicon****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 1 to entry: The atoms of each crystallite are symmetrically arrayed, but the multitude of crystallites is randomly jumbled.

Note 2 to entry: Often moulded as a cast ingot or pulled ribbon.

3.1.67.5

polycrystalline silicon

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 1 to entry: Polycrystalline silicon is known as thin film pc-Si.

Note 2 to entry: Polycrystalline silicon is also a term used in the feedstock silicon fabrication process.

3.1.67.6

single crystalline silicon

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 1 to entry: Single crystalline silicon is known as mono-crystalline and single crystal.

3.1.67.7

solar photovoltaic grade silicon

SOG

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

3.1.68

silicon photovoltaic cell

SEE: "cell/silicon photovoltaic cell", 3.1.12.10

3.1.69

single crystalline silicon

SEE: "silicon/single crystalline silicon", 3.1.67.6

3.1.70

solar photovoltaic

solar photovoltaics

pertaining to PV devices under the influence of sunlight

Note 1 to entry: All terms beginning with "solar photovoltaic" are listed under their respective "photovoltaic" names (3.1.48, 3.2.21, and 3.3.59).

3.1.71

stacked photovoltaic cell

SEE: "cell/stacked photovoltaic cell", 3.1.12.11

3.1.72

substrate

a) outer surface material on the back side of a photovoltaic module

b) basic material on which photovoltaic cells are manufactured

Note 1 to entry: The substrate is commonly referred to as the backsheet.

Note 2 to entry: Pertaining to crystalline cells, the substrate is the semiconductor wafer on which cells are formed.

Note 3 to entry: Pertaining to thin film cells, the substrate is the supporting material such as glass or stainless steel, on which the thin film is deposited.

3.1.73

superstrate

outer surface material on the front side of a photovoltaic module

3.1.74**tandem photovoltaic cell**

SEE: "cell/tandem photovoltaic cell", 3.1.12.12

3.1.75**transparent conducting oxide layer****TCO**

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

Note 1 to entry: See also "transparent electrode", 3.1.78.

3.1.76**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

3.1.77**thin film photovoltaic cell**

SEE: "cell/thin film photovoltaic cell", 3.1.12.13

3.1.78**transparent electrode**

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

3.1.79**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 3.3.

3.2.1**array**

SEE: "photovoltaic/photovoltaic array", 3.3.59.1

3.2.2**array cable**

SEE: "photovoltaic/photovoltaic array cable", 3.2.21.1

3.2.3**array junction box**

SEE: "junction box/array junction box", 3.2.16.1

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 1 to entry: 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.

3.2.7.1

line commutation

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

3.2.7.2

line commutation type

power conditioner operated with line commutation

3.2.7.3

self-commutation

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

3.2.7.4

self-commutation type

power conditioner operated with self-commutation

3.2.8

current control type inverter

SEE: "inverter/current control inverter", 3.2.15.1

3.2.9

current stiff type inverter

SEE: "inverter/current stiff inverter", 3.2.15.2

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", 3.2.21.2

3.2.12

generator junction box

SEE: "junction box/generator junction box", 3.2.16.2

3.2.13

high frequency link type inverter

SEE: "inverter/high frequency link inverter", 3.2.15.6

3.2.14**input voltage operating range**

input DC voltage range in which the power conditioner operates stably

Note 1 to entry: Unit: V.

3.2.15**inverter**

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

Note 1 to entry: An inverter is one of a number of components that is included in the term "power conditioner".

3.2.15.1**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

3.2.15.2**current stiff inverter**

inverter having an essentially smooth DC input electric current

3.2.15.3**grid-connected inverter**

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

Note 1 to entry: A grid-connected inverter is also known variously as a grid-intertie or a grid-tied inverter.

[SOURCE: IEC 60050-151:2001, 151-13-46]

3.2.15.4**grid-dependent inverter**

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

3.2.15.5**grid-interactive inverter**

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

Note 1 to entry: A grid-interactive inverter initiates a grid-parallel mode of operation.

3.2.15.6**high frequency link inverter**

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

3.2.15.7**module inverter**

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

Note 1 to entry: A module inverter is usually attached to the rear of a module.

Note 2 to entry: See also "AC photovoltaic module", 3.3.2.

3.2.15.8**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

3.2.15.9

stand-alone inverter

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

Note 1 to entry: A stand-alone inverter is also known as a "battery-powered inverter".

3.2.15.10

string inverter

inverter that is designed to operate with a single PV string

Note 1 to entry: The AC output of a string inverter can be connected in parallel to the output of other string inverters.

3.2.15.11

transformerless inverter

inverter without any isolation transformer

3.2.15.12

utility frequency link inverter

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

3.2.15.13

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

3.2.15.14

voltage control inverter

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

3.2.15.15

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

3.2.16.1

array junction box

junction box where PV strings are connected

3.2.16.2

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 to entry: "Secondary" refers to a rechargeable battery.

Note 2 to entry: Lead-acid batteries are commonly used in stand-alone PV systems.

3.2.17.1**lead-acid battery for PV systems**

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

Note 1 to entry: 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 2 to entry: A lead-acid battery in PV systems is commonly referred to as a "PV battery".

3.2.17.2**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 1 to entry: Builds up in the electrochemical cells.

3.2.17.3**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", 3.2.7.1

3.2.19**line commutation type**

SEE: "commutation/line commutation type", 3.2.7.2

3.2.20**non-islanding inverter**

SEE: "inverter/non-islanding inverter", 3.2.15.8

3.2.21**photovoltaic cable****photovoltaic cabling**

electrical cable (cabling) specifically designed for the purpose of carrying electric current from photovoltaic devices and enduring the environmental conditions commonly encountered in photovoltaic arrays

Note 1 to entry: Photovoltaic cables need to endure conditions as high temperatures, long-term UV exposure, long-term abrasion by wind, damage by animal.

Note 2 to entry: Several terms describe cabling components of a photovoltaic system.

3.2.21.1**photovoltaic array cable****photovoltaic direct-current main cable**

output cable of a photovoltaic array that carries the total current of the array

3.2.21.2**photovoltaic string cable**

cable interconnecting the modules in a photovoltaic string, or connecting the string to a combiner box, power conversion equipment or other direct-current loads

3.2.21.3**photovoltaic supply cable**

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

3.2.21.4

photovoltaic sub-array cable

output cable of a photovoltaic sub-array that carries the output current of its associated sub-array

3.2.22 Photovoltaic combiner box

3.2.22.1

photovoltaic string combiner box

enclosure where photovoltaic strings are electrically connected in parallel and where protection devices may be located if necessary

3.2.22.2

photovoltaic sub-array combiner box

enclosure where photovoltaic strings of a photovoltaic sub-array are electrically connected in parallel and where protection devices may be located if necessary

3.2.22.3

photovoltaic array combiner box

enclosure where photovoltaic sub-arrays are electrically connected and which may also contain overcurrent protection and/or disconnection devices

Note 1 to entry: Some arrays (generally smaller) do not contain sub-arrays but are simply made up of strings whereas other arrays (generally larger) are made up of multiple sub-arrays.

3.2.23

photovoltaic module junction box

closed or protected enclosure on a photovoltaic module in which circuits are electrically connected and where protection devices may be located if necessary

3.2.24

power conditioner

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

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

Note 2 to entry: See also "sub-system/power conditioning sub-system" (3.3.74.3), and "inverter" (3.2.15).

3.2.25

pulse width modulation control

PWM

pulse control in which the pulse width or frequency or both are modulated within each fundamental period to produce a certain output waveform

[SOURCE: IEC 60050-551:1998, 551-16-30]

3.2.26

self-commutation

SEE: "commutation/self-commutation", 3.2.7.3

3.2.27

self-commutation type

SEE: "commutation/self-commutation type", 3.2.7.4

3.2.28

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

3.2.29**solar photovoltaic**

SEE: "photovoltaic", 3.1.48

Note 1 to entry: All terms beginning with "solar photovoltaic" are listed under their respective "photovoltaic" names (3.1.48, 3.2.21, and 3.3.59).

3.2.30**stand-alone inverter**

SEE: "inverter/stand-alone inverter", 3.2.15.9

3.2.31**string cable**

SEE: "photovoltaic/photovoltaic string cable", 3.2.21.3

3.2.32**string inverter**

SEE: "inverter/string inverter", 3.2.15.10

3.2.33**supply cable**

SEE: "photovoltaic/photovoltaic supply cable", 3.2.21.4

3.2.34**support structure**

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

3.2.35**transformerless type inverter**

SEE: "inverter/transformerless inverter", 3.2.15.11

3.2.36**utility frequency link type inverter**

SEE: "inverter/utility frequency link inverter", 3.2.15.12

3.2.37**utility interactive inverter**

SEE: "inverter/utility interactive inverter", 3.2.15.13

3.2.38**utility interface disconnect switch**

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

3.2.39**valve regulated lead-acid battery**

SEE: "lead-acid battery/valve regulated lead-acid battery", 3.2.17.2

3.2.40**vented lead-acid battery**

SEE: "lead-acid battery/vented lead-acid battery", 3.2.17.3

3.2.41**voltage control type inverter**

SEE: "inverter/voltage control inverter", 3.2.15.14

3.2.42**voltage stiff type inverter**

SEE: "inverter/voltage stiff inverter", 3.2.15.15

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", 3.3.35.1

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", 3.3.35.2

3.3.4

AC side switchover

SEE: "photovoltaic system/grid backed-up photovoltaic system/AC side switchover", 3.3.65.5

3.3.5

array field

SEE: "photovoltaic/photovoltaic array field", 3.3.59.2

3.3.6

assembly

SEE: "photovoltaic/photovoltaic assembly", 3.3.59.3

3.3.7

backfeed operation

SEE: "operation/backfeed operation", 3.3.55.2

3.3.8

balance of system

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

building-attached photovoltaics

BAPV

relates to photovoltaic modules fastened onto building construction materials

3.3.10

building-integrated photovoltaics

BIPV

relates to photovoltaic modules providing one or more functions of the building envelope

3.3.11

centralized photovoltaic system

SEE: "photovoltaic system/centralized photovoltaic system", 3.3.65.1

3.3.12

collective electrification system

CES

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

3.3.13**DC/DC interface**

SEE: "interface/DC/DC interface", 3.3.35.4

3.3.14**DC interface**

SEE: "interface/DC interface", 3.3.35.3

3.3.15**DC side**

SEE: "interface/DC side of the interface", 3.3.35.5

3.3.16**DC side switchover**

SEE: "photovoltaic system/grid backed-up photovoltaic system /DC side switchover", 3.3.65.5

3.3.17**dispatchable electric system**

SEE: "power system/dispatchable power system", 3.3.67.1

3.3.18**dispersed array system**

SEE: "photovoltaic system/dispersed photovoltaic system/ dispersed-array system", 3.3.65.2

3.3.19**dispersed photovoltaic system**

SEE: "photovoltaic system/dispersed photovoltaic system", 3.3.65.2

3.3.20**distributed generation PV system**

SEE: "photovoltaic system/distributed generation PV system", 3.3.65.2

Note 1 to entry: See also "distributed generation system", 3.3.21.

3.3.21**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

3.3.22**distributed generator****DG**

electrical generating equipment connected directly to a distributed generation system

Note 1 to entry: A distributed generator is sometimes called a non-utility generator, abbreviated as a "NUG".

3.3.23**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 1 to entry: In some parts of the world, the distribution system operates at a nominal voltage of 34 500 V.

3.3.24**domestic photovoltaic system**

SEE: "photovoltaic system/domestic photovoltaic system", 3.3.65.4

3.3.25

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 1 to entry: "Electrical utility" is preferred over "electric utility".

3.3.26

electrify

a) to supply electricity, electrical circuits, and associated generation, delivery and management equipment

b) to impose a voltage or electric current onto an electrical circuit or device

Note 1 to entry: "Electrification" is related to "electrify".

3.3.27

generator

apparatus that converts non-electric energy into electric energy

Note 1 to entry: A generator does not include energy storage devices or power conditioners.

Note 2 to entry: See also "photovoltaic/ photovoltaic generator", 3.3.59.4.

3.3.28

genset

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

3.3.29

grid

common reference to an electricity distribution and/or transmission system

Note 1 to entry: "Electric power network" refers to a grid.

3.3.29.1

microgrid

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

Note 1 to entry: A typical microgrid has a total load of less than 100 kVA and is supplied by micropower systems or micropower stations.

Note 2 to entry: A microgrid usually serves villages and is supplied by fossil-fuel generators and/or renewable energy generators.

3.3.29.2

utility grid

grid for which an electrical utility is responsible

3.3.30

grid backed-up photovoltaic system

SEE: "photovoltaic system/grid backed-up photovoltaic system", 3.3.65.5

3.3.31

grid-connected operation

SEE: "operation/grid-connected operation", 3.3.55.3

3.3.32

grid-connected photovoltaic system

SEE: "photovoltaic system/grid-connected photovoltaic system", 3.3.65.6

3.3.33**hybrid photovoltaic system**

SEE: "photovoltaic system/hybrid photovoltaic system", 3.3.65.7

3.3.34**individual electrification system****IES**

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

Note 1 to entry: See also " photovoltaic system/domestic photovoltaic system" (3.3.65d) and "solar home system" (3.3.71).

3.3.35**interface**

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

3.3.35.1**AC/AC interface**

interface between an inverter and its AC loads

Note 1 to entry: An AC/AC interface may include AC/AC voltage conversion, filters and connection of auxiliary AC electricity supplies.

3.3.35.2**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

3.3.35.3**DC interface**

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

3.3.35.4**DC/DC interface**

interface between a DC conditioner output and its DC loads

Note 1 to entry: A DC/DC interface may include DC switchgear, filters and connection of an auxiliary DC electricity supply.

3.3.35.5**DC side of the interface**

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

3.3.35.6**utility interface**

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

Note 1 to entry: A utility interface may include AC/AC voltage conversion and utility interactive protective functions.

3.3.36**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 to entry: The generated electric power and the load in an island may be any combination of customer-owned and utility-owned.

3.3.36.1

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 1 to entry: An intentional island includes an agreement between the controlling utility and the operators of customer-owned generation.

3.3.36.2

unintentional island

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

3.3.36.3

run-on

amount of time that an unintentional island exists

Note 1 to entry: 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 2 to entry: The time represented by run-on is also referred to as "trip time".

3.3.37

islanding operation

SEE: "operation/islanding operation", 3.3.55.5

3.3.38

isolated operation

SEE: "operation/isolated operation", 3.3.55.6

3.3.39

isolated photovoltaic system

SEE: "photovoltaic system/isolated photovoltaic system", 3.3.65.8

3.3.40

isolated site

SEE: "site/isolated site", 3.3.70.1

3.3.41

load offset system

see "power system/load offset power system", 3.3.67.2

3.3.42

master control and monitoring sub-system

SEE: "sub-system/monitor and control sub-system", 3.3.74.1

3.3.43

merchant power system

SEE: "power system/merchant power system", 3.3.67.3

3.3.44

microgrid

system for the distribution of electricity over a limited area and within clearly defined electrical boundaries that acts as a single controllable entity that can connect and disconnect from the general or regional electricity distribution systems

Note 1 to entry: A microgrid meets regional standards for the design and operation of electricity distribution systems.

Note 2 to entry: A microgrid can operate as stand-alone or connected to a general or regional electricity distribution system.

3.3.45**micropower system**

SEE: "power system/micropower system", 3.3.67.4

3.3.46**mode**

state in which a PV system or an inverter is operating

Note 1 to entry: For definitions of various modes of operation, see "operation", 3.3.55.

3.3.47**monitor and control sub-system**

SEE: "sub-system/monitor and control sub-system", 3.3.74.1

3.3.48**multi-dispersed photovoltaic system**

SEE: "photovoltaic system/dispersed photovoltaic system/multi-dispersed photovoltaic system", 3.3.65.2

3.3.49**multi-source photovoltaic system**

SEE: "photovoltaic system/multi-source photovoltaic system", 3.3.65.9

3.3.50**non-dispatchable power system**

SEE: "power system/non-dispatchable", 3.3.67.5

3.3.51**non-domestic photovoltaic system**

SEE: "photovoltaic system/non-domestic photovoltaic system", 3.3.65.10

3.3.52**off-grid operation**

SEE: "operation/off-grid operation", 3.3.55.7

3.3.53**off-grid photovoltaic system**

SEE: "photovoltaic system/off-grid photovoltaic system", 3.3.65.11

3.3.54**on-grid**

SEE: "operation/grid-connected operation", 3.3.55.3

3.3.55**operation <photovoltaics>**

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

Note 1 to entry: Operation includes switching, controlling, monitoring and maintenance as well as any work activities.

[SOURCE: IEC 60050-151:2001, 151-11-28, modified]

3.3.55.1**autonomous operation**

also known as stand-alone operation (3.3.55.9)

3.3.55.2**backfeed operation**

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

Note 1 to entry: Backfeed operation arises when the generating system generates more electricity than is used by local electrical loads.

3.3.55.3

grid-connected operation

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

Note 1 to entry: In a grid-connected operation, site loads will be electrified by either or both the utility or the PV system.

Note 2 to entry: Electricity will be able to flow into the utility if the utility permits backfeed operation.

3.3.55.4

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

3.3.55.5

islanding operation

mode of operation for operating an island

Note 1 to entry: Islanding operation includes maintaining frequency, voltage, power reserve, and instantaneous active and reactive power requirements.

3.3.55.6

isolated operation

stable and temporary operation of a discrete part of a grid

Note 1 to entry: See also IEC 60050-603:1986, 603-04-33.

3.3.55.7

off-grid operation

also known as stand-alone operation (3.3.55.9)

3.3.55.8

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 1 to entry: Parallel operation is also known as grid-parallel operation.

3.3.55.9

stand-alone operation

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

3.3.56

panel

SEE: "photovoltaic/photovoltaic panel", 3.3.59.5

3.3.57

parallel circuit of modules

circuit in which PV modules are connected in parallel

3.3.58

parallel operation

SEE: "operation/parallel operation", 3.3.55.8

3.3.59 Photovoltaic

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

3.3.59.1

photovoltaic array

mechanical and electrical assembly of photovoltaic modules, photovoltaic panels or photovoltaic sub-arrays and its support structure

Note 1 to entry: A photovoltaic array includes all components up to the d.c. input terminals of the inverter or other power conversion equipment or d.c. loads.

Note 2 to entry: A photovoltaic array does not include its foundation, tracking apparatus, thermal control, and other such components.

3.3.59.2

photovoltaic array field

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

3.3.59.3

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 1 to entry: 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.

3.3.59.4

photovoltaic generator

generator that uses the photovoltaic effect to convert sunlight into electricity

Note 1 to entry: The PV generator is the PV array in a PV system.

Note 2 to entry: A PV generator does not include energy storage devices or power conditioners.

3.3.59.5

photovoltaic panel

PV modules mechanically integrated, pre-assembled and electrically interconnected

3.3.59.6

photovoltaic string

circuit of series-connected PV modules

3.3.59.7

photovoltaic sub-array

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

3.3.60

photovoltaic components

parts of a PV system

Note 1 to entry: PV components could include, for example, modules, inverters, electrical storage devices, and other balance of system components.

3.3.61

photovoltaic installation

constructed components of a PV system

3.3.62

photovoltaic energy system

another term for a PV power system, 3.3.64

3.3.63

photovoltaic plant

another term for a PV system

Note 1 to entry: A PV plant is also known as a PV power station. Such plants are normally grid-connected and large.

3.3.64

photovoltaic power system

PVPS

photovoltaic system

3.3.65

photovoltaic system

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

Note 1 to entry: 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.

3.3.65.1

centralized photovoltaic system

grid-connected PV system that generates bulk electricity

3.3.65.2

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

Note 1 to entry: 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.

3.3.65.3

distributed generation PV system

PV system that is also a distributed generation system

3.3.65.4

domestic photovoltaic system

PV system that electrifies household loads

Note 1 to entry: See also "solar home system", 3.3.71.

3.3.65.5

grid backed-up photovoltaic system

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

Note 1 to entry: 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.

3.3.65.6

grid-connected photovoltaic system

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

Note 1 to entry: Also known as "utility intertied", "utility interconnected", or "grid-tied".

3.3.65.7

hybrid photovoltaic system

see "multi-source photovoltaic system", 3.3.65.9

3.3.65.8

isolated photovoltaic system

PV system that functions only in an isolated mode of operation

Note 1 to entry: Also known as a "stand-alone photovoltaic system".

3.3.65.9

multi-source photovoltaic system

PV system operating in parallel with other electricity generators

Note 1 to entry: Also called a "PV-hybrid" system.

3.3.65.10

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.)

3.3.65.11

off-grid photovoltaic system

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

Note 1 to entry: Also known as a "stand-alone photovoltaic system".

3.3.65.12

off-grid domestic photovoltaic system

stand-alone PV system installed so as to electrify households

Note 1 to entry: Also referred to as a solar home system.

3.3.65.13

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.

3.3.65.14

stand-alone photovoltaic system

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

Note 1 to entry: See "operation/stand-alone operation", 3.3.55.9.

3.3.65.15

utility interactive photovoltaic system

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

3.3.65.16

off-grid village photovoltaic system

stand-alone PV system electrifying a village

3.3.66

power conditioning sub-system

see "sub-system/power conditioning sub-system", 3.3.74.3

3.3.67

power system

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

Note 1 to entry: A power system is also known as a power station or an electric generating station.

[SOURCE: IEC 60050-601:1985, 601-03-01, modified]

3.3.67.1

dispatchable power system

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

Note 1 to entry: For example, a fossil-fuelled engine-powered generator is dispatchable.

3.3.67.2

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

3.3.67.3

merchant power system

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

3.3.67.4

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 1 to entry: The typical generating capacity of a micropower system is less than 100 kVA.

3.3.67.5

non-dispatchable power system

Note 1 to entry: For example, a renewable energy generator is a non-dispatchable.

3.3.68

remote site

SEE:"site/remote site", 3.3.70.2

3.3.69

safety disconnect control and monitoring sub-system

SEE:"sub-system/safety disconnect control and monitoring sub-system", 3.3.74.4

3.3.70

site

geographical location of a system

3.3.70.1**isolated site**

location not connected to the utility grid

3.3.70.2**remote site**

location far from developed infrastructures, specifically the utility grid

3.3.71**solar home system****SHS**

stand-alone PV system installed in a household

Note 1 to entry: See also " photovoltaic system/domestic photovoltaic system" (3.3.65.4) and "individual electrification system" (3.3.34).

3.3.72**solar photovoltaic**

Note 1 to entry: All terms beginning with "solar photovoltaic" are listed under their respective "photovoltaic" names (3.1.48, 3.2.21, and 3.3.59).

3.3.73**stand-alone microgrid**

microgrid not interconnected to general or regional electricity distribution systems

3.3.74**sub-system**

assembly of components

The following terms describe common sub-systems:

3.3.74.1**monitor and control sub-system****MCM**

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

3.3.74.2**photovoltaic generator sub-system**

components that convert light energy into electricity using the PV effect

3.3.74.3**power conditioning sub-system**

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

Note 1 to entry: 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.

3.3.74.4**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

3.3.74.5**storage sub-system**

component(s) that store(s) energy

3.3.75

system

SEE: "photovoltaic system", 3.3.65

3.3.76

utility grid

SEE: "grid/utility grid", 3.3.29.2

3.3.77

utility interactive photovoltaic system

SEE: "photovoltaic system/utility interactive photovoltaic system", 3.3.65.15

3.3.78

utility interface

SEE: "interface/utility interface", 3.3.35.6

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", 3.4.16.1

3.4.2

ampere-hour efficiency

SEE: "efficiency/ampere-hour efficiency", 3.4.26.1

3.4.3

aperture area

SEE: "cell area/active cell area", 3.4.11.2, and "module area/active module area" 3.4.47.2

3.4.4

area

SEE: "cell area/active cell area", 3.4.11.2, and "module area/active module area" 3.4.47.2

3.4.5

array capture losses

SEE: "losses/array capture losses", 3.4.40.1

3.4.6

array efficiency

SEE: "efficiency/array efficiency", 3.4.26.2

3.4.7

array yield

SEE: "yield/array yield", 3.4.99.1

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", 3.4.40.2

3.4.10 Capacity

3.4.10.1

array capacity

rated power generation of a PV array

Note 1 to entry: Unit: W.

3.4.10.2

capacity factor

L_{SP}

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

Note 1 to entry: Unit: dimensionless, usually expressed as a percentage (%) over a period of time such as a month or year.

3.4.10.3

installed capacity

SEE: "rated capacity", 3.4.10.4

3.4.10.4

rated capacity

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

Note 1 to entry: Pertaining to PV devices: see "rated/rated power", 3.4.70.6.

Note 2 to entry: Pertaining to PV systems: see "power/rated system power", 3.4.70.10.

Note 3 to entry: Unit: Ah or Wh.

3.4.10.5

residual capacity

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

Note 1 to entry: Unit: Ah or Wh.

3.4.11

cell area

total or active area of a photovoltaic cell

Note 1 to entry: Unit: m².

3.4.11.1

total cell area

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

Note 1 to entry: Total cell area includes the area of any metallisation lines.

Note 2 to entry: Total cell area is preferred for reporting cell efficiency.

3.4.11.2

active cell area

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

Note 1 to entry: Active cell area equals the total cell area minus the area contribution of the metallisation lines.

Note 2 to entry: Active cell area is sometimes referred to as "cell aperture area".

3.4.12

cell junction temperature

T_j

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

Note 1 to entry: Unit: °C.

3.4.13

charging efficiency

SEE: "efficiency/charging efficiency", 3.4.26.3

3.4.14 Coefficient

3.4.14.1

current-temperature coefficient

α

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

Note 1 to entry: Both absolute and relative values are used.

Note 2 to entry: 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 to entry: If the current-temperature coefficient has the unit of $A \cdot K^{-1}$, 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 to entry: The short-circuit current varies with irradiance and to a lesser extent with temperature.

Note 5 to entry: Unit: $A \cdot K^{-1}$ (absolute), K^{-1} (relative).

3.4.14.2

voltage-irradiance coefficient

δ

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, $\ln(G_1 / G_2)$

Note 1 to entry: Unit: dimensionless.

3.4.14.3

voltage-temperature coefficient

β

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

Note 1 to entry: 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 2 to entry: If the voltage-temperature coefficient has the unit of $V \cdot K^{-1}$, 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 3 to entry: Unit: $V \cdot K^{-1}$ (absolute), K^{-1} (relative).

3.4.15

collection efficiency

SEE: "efficiency/collection efficiency", 3.4.26.4.

3.4.16

conditions

conditions under which a PV device is evaluated

Note 1 to entry: The conditions under which a PV device is evaluated typically specify irradiance, ambient temperature, spectral distribution and/or air mass.

3.4.16.1

acceptance test conditions

ATC

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

3.4.16.2

operating conditions

conditions under which a PV device is operating

3.4.16.3

optional test conditions

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

3.4.16.4

standard operating conditions

SOC

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

3.4.16.5

standard test conditions

STC

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

3.4.16.6

test conditions

conditions under which a device is tested

3.4.17

conversion efficiency

SEE: "efficiency/PV conversion efficiency", 3.4.26.5

3.4.18

conversion factor

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

Note 1 to entry: Unit: dimensionless, usually expressed as a percentage, %.

3.4.19

current density <photovoltaic cell>

J

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

Note 1 to entry: Unit: $\text{A}\cdot\text{cm}^{-2}$.

3.4.20

current-temperature coefficient

SEE: "coefficient/current-temperature coefficient", 3.4.14.1

3.4.21

current-voltage characteristic

I - V

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

Note 1 to entry: 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 to entry: 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.

Note 3 to entry: Formula: $I = f(V)$.

3.4.22

DC ripple factor

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

Note 1 to entry: 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.

Note 2 to entry: Unit: dimensionless, usually expressed as a percentage, %.

3.4.23

dependency on solar energy

D_P

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})

Note 1 to entry: Unit: dimensionless, usually expressed as a percentage (%) over a period of time such as a month or year.

3.4.24

depth of discharge

DOD

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

Note 1 to entry: The ratio of the discharge amount to the rated capacity is generally used.

Note 2 to entry: Unit: dimensionless, usually expressed as a percentage, %.

3.4.25

effective energy efficiency

SEE: "efficiency/effective energy efficiency", 3.4.26.6

3.4.26

efficiency

η

ratio of output quantity to input quantity

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

Note 2 to entry: Unit: dimensionless, usually expressed as a percentage, %.

3.4.26.1

ampere-hour efficiency

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

Note 1 to entry: 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).

3.4.26.2

array efficiency

sunlight to electricity conversion efficiency of the PV array

3.4.26.3

charging efficiency

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

3.4.26.4

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

3.4.26.5

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 1 to entry: See also "conditions/standard test conditions", 3.4.16.5.

3.4.26.6

effective energy efficiency

energy efficiency during an identified period

3.4.26.7

inverter efficiency

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

3.4.26.8

mean array efficiency

η_{Amean}
 average PV array efficiency

Note 1 to entry: Mean PV array efficiency is useful for comparison with the rated PV array efficiency.

Note 2 to entry: The difference between mean and rated efficiency represents diode, wiring, mismatch and other losses during PV system operation.

3.4.26.9

overall system efficiency

η_{tot}
 efficiency of the whole system including all the electricity sources

Note 1 to entry: Overall system efficiency is derived from the electricity supplied to the loads based on the solar irradiation and fuel supplies.

3.4.26.10

partial efficiency

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

3.4.26.11

partial load efficiency

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

3.4.26.12

power efficiency

ratio of active output power to active input power

3.4.26.13

rated efficiency

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

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

Note 1 to entry: See also "conditions/standard test conditions", 3.4.16.5.

3.4.26.14

system efficiency

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

Note 1 to entry:

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).

Note 2 to entry: Unit: dimensionless, usually expressed as a percentage (%) over a period of time such as a month or year.

3.4.26.15

efficiency tolerance

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

Note 1 to entry: Unit: dimensionless, usually expressed as a percentage (%).

3.4.26.16

watt-hour efficiency

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

Note 1 to entry:

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 2 to entry: 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.

3.4.26.17

weighted average conversion efficiency

method of estimating the effective energy efficiency

Note 1 to entry: 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

EMI

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

[SOURCE: IEC 60050-161:1990, 161-01-06]

3.4.28

energy

ability of a physical system to do work

Note 1 to entry: Unit: J, though kWh is commonly used in the electrical industry.

3.4.28.1

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

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

Note 1 to entry: Unit: °C.

3.4.30

fill factor

FF

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

Note 1 to entry:

It is calculated by:

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

Note 2 to entry: Fill factor is often used to indicate the electricity production quality of a device.

Note 3 to entry: Unit: dimensionless, usually expressed as a percentage, %.

3.4.31

final annual yield

SEE: "yield/final annual yield", 3.4.99.2

3.4.32

final system yield

SEE: "yield/final system yield", 3.4.99.3

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 1 to entry: See also "maximum power/maximum power point tracking", 3.4.43.4.

3.4.34

installed capacity

SEE: "capacity/installed capacity", 3.4.10.3

3.4.35

installed power

SEE: "maximum power/maximum power under standard test conditions", 3.4.43.7

3.4.36

inverter efficiency

SEE: "efficiency/inverter efficiency", 3.4.26.7

3.4.37

inverter mismatch loss

SEE: "mismatch loss/inverter mismatch loss", 3.4.46.1

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 to entry: Usually, linearity is expressed as a normalised standard deviation of the line slope.

Note 2 to entry: 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 1 to entry: See also IEC 60050-151:2001, 151-15-15.

3.4.39.1

load current

I_L

electric current supplied to a load by a PV system

Note 1 to entry: Unit: A.

3.4.39.2

load power

P_L

electric power supplied to a load by a PV system

Note 1 to entry: Unit: W.

3.4.39.3**load voltage** V_L

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

Note 1 to entry: Unit: V.

3.4.39.4**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**

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

Note 1 to entry: See also IEC 60050-151:2001, 151-15-26.

Note 2 to entry: Unit: W, J, though kWh is commonly used in the electrical industry.

3.4.40.1**array capture losses** L_c

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

Note 1 to entry: 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.

3.4.40.2**balance of system losses** L_{BOS}

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

3.4.41**normalised losses**

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 1 to entry: Normalised losses are commonly calculated from a difference in given yields.

Note 2 to entry: 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.**3.4.42****maximum input voltage**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

Note 1 to entry: Unit: V.

3.4.43**maximum power** P_{max} , may also be known as P_{mpp}

power generated at the maximum power point

Note 1 to entry: Unit: W.

3.4.43.1**maximum power current** I_{Pmax}

electric current at the conditions of maximum power

Note 1 to entry: Unit: A.

3.4.43.2

maximum power irradiance coefficient

χ

ratio-change of the maximum power ($P_{\max 1} / P_{\max 2}$) of a PV device as a function of the ratio-change of the natural logarithm of irradiance, $\ln(G_1 / G_2)$

Note 1 to entry: Unit: dimensionless.

3.4.43.3

maximum power point

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

3.4.43.4

maximum power point tracking

MPPT

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

Note 1 to entry: See also "fixed voltage operation", 3.4.33.

3.4.43.5

maximum power temperature coefficient

γ

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

Note 1 to entry: Both absolute and relative values are used.

Note 2 to entry: 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.

Note 3 to entry: Unit: $W \cdot K^{-1}$ (absolute), K^{-1} (relative).

3.4.43.6

maximum power under standard operating conditions

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

Note 1 to entry: See also "conditions/standard operating conditions", 3.4.16.4.

3.4.43.7

maximum power under standard test conditions

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

Note 1 to entry: See also "conditions/standard test conditions", 3.4.16.5.

3.4.43.8

maximum power voltage

$V_{P_{\max}}$

voltage at the conditions of maximum power

Note 1 to entry: Unit: V.

3.4.43.9

maximum power voltage under standard operating conditions

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

Note 1 to entry: See also "conditions/standard operating conditions", 3.4.16.4.

Note 2 to entry: Unit: V.

3.4.43.10**maximum power voltage under standard test conditions**

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

Note 1 to entry: See also "conditions/standard test conditions", 3.4.16.5.

Note 2 to entry: Unit: V.

3.4.44**mean array efficiency**

SEE: "efficiency/mean array efficiency", 3.4.26.8

3.4.45**mismatch error**

SEE: "spectral responsivity/spectral response mismatch error", 3.4.85.1

3.4.46 Mismatch loss**3.4.46.1****inverter mismatch loss**

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

Note 1 to entry: Unit: W or dimensionless and expressed as a percentage, %.

3.4.46.2**module mismatch loss**

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 1 to entry: PV module mismatch loss arises because of differences in individual device I-V characteristics.

Note 2 to entry: Unit: W or dimensionless and expressed as a percentage, %.

3.4.47**module area**

total or active area of a photovoltaic module

Note 1 to entry: Unit: m².

3.4.47.1**total module area**

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

Note 1 to entry: 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 to entry: Total module area is preferred for reporting module efficiency.

3.4.47.2**active module area**

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

Note 1 to entry: Active module area equals the sum of the total cell area in the module.

Note 2 to entry: Active module area is sometimes referred to as "module aperture area".

3.4.48**module mismatch loss**

SEE: "mismatch loss/module mismatch loss", 3.4.46.2

3.4.49

module packing factor

ratio of the total PV cell area to the module area

Note 1 to entry: Unit: dimensionless, usually expressed as a percentage, %.

3.4.50

module surface temperature

mean temperature of the back surface of a PV module

Note 1 to entry: Unit: °C.

3.4.51

module temperature

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

Note 1 to entry: Unit: °C.

3.4.52

no load loss

input power of the power conditioner when its load is disconnected

Note 1 to entry: Unit: W.

3.4.53

nominal operating photovoltaic cell temperature

NOCT

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

Note 1 to entry: Unit: °C.

3.4.54

nominal system power

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 to entry: 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 to entry: See also "conditions/standard operating conditions", 3.4.16.4.

Note 3 to entry: Unit: W.

3.4.55

non-uniformity

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

Note 1 to entry: 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 to entry: The area scanned to find the minimum and maximum irradiance may be the solar simulator test plane, or it may be the module footprint.

Note 3 to entry: Unit: dimensionless, usually expressed as a percentage, %.

3.4.56

normalised losses

SEE: "losses/normalised losses", 3.4.40.3.

3.4.57**open-circuit voltage <photovoltaic devices>** V_{OC}

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

Note 1 to entry: Unit: V.

3.4.57.1**open-circuit voltage under standard test conditions** $V_{OC\ STC}$

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

Note 1 to entry: See also "conditions/standard test conditions", 3.4.16.5.

3.4.58**operating conditions**

SEE: "conditions/operating conditions", 3.4.16.2

3.4.59**optional test conditions**

SEE: "conditions/optional test conditions", 3.4.16.3

3.4.60**overall system efficiency**

SEE: "efficiency/overall system efficiency", 3.4.26.9

3.4.61**overload capability**

output power level beyond which permanent damage occurs to a device

Note 1 to entry: Overload capability is the ratio of overload power to rated load power for a period of time.

Note 2 to entry: Unit: dimensionless, usually expressed as a percentage (%) and minutes.

3.4.62**partial efficiency**

SEE: "efficiency/partial efficiency", 3.4.26.10

3.4.63**partial load efficiency**

SEE: "efficiency/partial load efficiency", 3.4.26.11

3.4.64**partial state of charge** $PSOC$

SEE: "state of charge/partial state of charge", 3.4.89.1

3.4.65**peak power**

see "rated/rated power", 3.4.70.6

3.4.66**peak sun hours**

SEE: "rated/rated sun-hours", 3.4.70.9

3.4.67**performance ratio** PR

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

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

Note 2 to entry: The performance ratio is commonly calculated from the ratio of the final system yield over the reference yield.

Note 3 to entry: Unit: dimensionless, usually expressed as a percentage, %.

3.4.68

photovoltaic energy

SEE: "energy/photovoltaic energy", 3.4.28.1

3.4.69

power efficiency

SEE: "efficiency/power efficiency", 3.4.26.12

3.4.70

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 to entry: See also IEC 60050-151:2001, 151-16-08.

3.4.70.1

rated capacity

SEE: "capacity/rated capacity", 3.4.10.4

3.4.70.2

rated condition

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

3.4.70.3

rated current

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

Note 1 to entry: Unit: A.

3.4.70.4

rated efficiency

efficiency of a component at specified operating conditions

Note 1 to entry: Unit: dimensionless, usually expressed as a percentage, %.

3.4.70.5

rated load

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

3.4.70.6

rated power

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

Note 1 to entry: Unit: W.

3.4.70.7**rated power at STC** P_{STC}

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

Note 1 to entry: Unit: W.

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

Note 3 to entry: See also "conditions/standard test conditions", 3.4.16.5.

3.4.70.8**rated power at SOC** P_{SOC}

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

Note 1 to entry: Unit: W.

3.4.70.9**rated sun-hours**

amount of time that the solar irradiance is at reference levels

Note 1 to entry: Unit: h.

Note 2 to entry: Rated sun-hours is usually expressed on a daily basis.

Note 3 to entry: If $G_{\text{I,ref}} = 1 \text{ kW}\cdot\text{m}^{-2}$ then "rated sun-hours" over any period of time is numerically equal to the irradiation over the same period as expressed in $\text{kWh}\cdot\text{m}^{-2}$.

3.4.70.10**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 1 to entry: See also "conditions/standard operating conditions", 3.4.16.4.

3.4.70.11**rated voltage** V_R

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

Note 1 to entry: Unit: V.

3.4.71**reference spectral irradiance distribution**

tabulation of spectral irradiance, spectral photon irradiance and cumulative integrated irradiance versus wavelength

Note 1 to entry: See Table 1 of IEC 60904-3:2016.

3.4.72**reference yield**

SEE: "yield/reference yield", 3.4.99.4

3.4.73**relative spectral response**

SEE: "spectral responsivity/relative spectral response", 3.4.85.2

3.4.74

relative spectral response under load

SEE: "spectral responsivity/relative spectral response under load", 3.4.85.3

3.4.75

residual capacity

SEE: "capacity/residual capacity", 3.4.10.5

3.4.76

reverse power flow

electric power flow from a generating system into utility distribution grid

Note 1 to entry: Reverse power flow is known as "backfeed". See "operation/backfeed operation", 3.3.55.2.

3.4.77

safe extra low voltage

SELV

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

Note 1 to entry: Unit: V.

Note 2 to entry: For DC systems, SELV is 130 V and below.

3.4.78

self-discharge

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

3.4.79

series resistance

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

Note 1 to entry: Unit: Ω .

3.4.80

shadow cover rate

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

Note 1 to entry: Unit: dimensionless, usually expressed as a percentage, %.

Note 2 to entry:

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 3 to entry: 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.

3.4.81

sheet resistance

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

Note 1 to entry: Unit: Ω ("Ohms per square").

3.4.82**short-circuit current** I_{SC}

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 to entry: Unit: A.

Note 2 to entry: See also IEC 60050-195:1998, 195-05-18.

3.4.82.1**short-circuit current under standard test conditions** $I_{SC\text{ STC}}$

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

Note 1 to entry: Unit: A.

Note 2 to entry: See also "conditions/standard test conditions", 3.4.16.5.

3.4.83**shunt resistance**

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

Note 1 to entry: Unit: Ω .

3.4.84**spectral mismatch error**

error introduced in the testing of a photovoltaic 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

3.4.85**spectral responsivity** $S(\lambda)$

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

Note 1 to entry: Unit: $A \cdot W^{-1}$.

Note 2 to entry: The term "response" instead of responsivity is commonly and colloquially used.

Note 3 to entry: 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.

3.4.85.1**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

3.4.85.2**relative spectral response** $S(\lambda)_{rel}$

spectral response normalised to unity at wavelength of maximum response

Note 1 to entry: Unit: dimensionless.

Note 2 to entry:

It is calculated by:

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

3.4.85.3

relative spectral response under load

$S_V(\lambda)_{\text{rel}}$

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

Note 1 to entry: Unit: dimensionless.

Note 2 to entry:

It is calculated by:

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

3.4.85.4

spectral response under load

$S_{V\lambda}$

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

3.4.86

standard operating conditions

SEE: "conditions/standard operating conditions", 3.4.16.4

3.4.87

standard test conditions

STC

reference values of in plane irradiance ($G_{\text{I,ref}} = 1\,000 \text{ W/m}^2$), photovoltaic cell junction temperature ($25 \text{ }^\circ\text{C}$), and a reference spectral irradiance distribution calculated for $AM = 1,5$ to be used during the testing of any photovoltaic device

SEE: "conditions/standard test conditions", 3.4.16.5

3.4.88

standby loss

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

Note 1 to entry: Unit: W.

3.4.89

state of charge

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

Note 1 to entry: Unit: dimensionless, usually expressed as a percentage, %.

3.4.89.1

partial state of charge

PSOC

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

Note 1 to entry: Unit: dimensionless, usually expressed as a percentage, %.

3.4.90

system efficiency

SEE: "efficiency/system efficiency", 3.4.26.14

3.4.91

system output energy

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

Note 1 to entry: Unit: J, though usually expressed as kWh.

3.4.92

system power

SEE: "rated/rated system power", 3.4.70.10

3.4.93

test conditions

SEE: "conditions/test conditions", 3.4.16.6

3.4.94

total harmonic distortion

THD

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 1 to entry: Unit: dimensionless, usually expressed as a percentage, %.

Note 2 to entry: See also IEC 60050-551:1998, 551-17-06.

3.4.95

voltage-irradiance coefficient

ratio-change of the open-circuit voltage (V_{oc1}/V_{oc2}) of a photovoltaic device as a function of the ratio-change of the natural logarithm of irradiance, $\ln(G1/G2)$

SEE: "coefficient/voltage-irradiance coefficient", 3.4.14.2

Note 1 to entry: Unit: dimensionless.

3.4.96

voltage-temperature coefficient

SEE: "coefficient/voltage-temperature coefficient", 3.4.14.3

3.4.97

watt-hour efficiency

SEE: "efficiency/watt-hour efficiency", 3.4.26.16

3.4.98

weighted average conversion efficiency

SEE: "efficiency/weighted average conversion efficiency", 3.4.26.17

3.4.99

yield

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

Note 2 to entry: A yield indicates actual device operation relative to its rated capacity.

Note 3 to entry: A yield is calculated from the ratio of the energy generated to the rated device power.

Note 4 to entry: 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.

3.4.99.1

array yield

Y_A

PV array energy generated per unit of rated PV array capacity

3.4.99.2

final annual yield

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

3.4.99.3

final system yield

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

3.4.99.4

reference yield

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 $G_{l,ref}$.

Note 1 to entry: If $G_{l,ref} = 1 \text{ kW}\cdot\text{m}^{-2}$ then the irradiation as expressed in $\text{kWh}\cdot\text{m}^{-2}$ over any period of time is numerically equal to energy as expressed in $\text{kWh}\cdot\text{kW}^{-1}$ 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", 3.5.7.1

3.5.2

monochromatic light source

light source having a narrow bandwidth

Note 1 to entry: For spectral response measurements, a light source with a broad spectral irradiance distribution is used together with either a monochromator or bandpass filters.

Note 2 to entry: 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", 3.5.8.2

3.5.5

pyranometer

SEE: "radiometer/pyranometer", 3.5.7.2

3.5.6

pyrheliometer

SEE: "radiometer/pyrheliometer", 3.5.7.3

3.5.7

radiometer

instrument for measuring the intensity of solar irradiance

Note 1 to entry: See also IEC60050-845:1987, 845-05-06.

Note 2 to entry: Commonly, a radiometer is a thermal instrument using thermocouples or thermopiles and has a sensitivity independent of the wavelength of incoming radiation.

3.5.7.1

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

3.5.7.2

pyranometer

radiometer normally used to measure global irradiance on a horizontal plane

Note 1 to entry: A pyranometer can also be used to measure diffuse irradiance when used with a shade ring or disc.

Note 2 to entry: A pyranometer can also be used to measure total irradiance on an inclined plane, which would include radiation reflected from the foreground.

3.5.7.3

pyrheliometer

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

Note 1 to entry: A pyrheliometer is sometimes called a normal incidence pyrheliometer, or NIP.

3.5.7.4

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

3.5.8.1

solar simulator class

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

Note 1 to entry: Three classes of solar simulators are defined, class A, B and C, with A being the best.

3.5.8.2

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

3.5.8.3

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", 3.5.7.4

3.5.10

steady-state type solar simulator

SEE: "solar simulator/steady-state type solar simulator", 3.5.8.3

3.5.11

temporal simulator instability

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 1 to entry: Unit: dimensionless, usually expressed as a percentage, %.

Note 2 to entry: 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.

3.5.12

white bias light

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

3.6 Environmental parameters

3.6.1

air mass index

AM

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 1 to entry: Unit: dimensionless.

Note 2 to entry: 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 P_0 . Standard operating conditions, 3.4.16.4, and standard test conditions, 3.4.16.5, use an AM of 1,5.

3.6.2

albedo

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

Note 1 to entry: Unit: dimensionless, usually expressed as a percentage, %.

Note 2 to entry: The albedo term compares the reflectance of a ground surface to solar radiation.

3.6.3

ambient temperature

T_{amb}

average temperature of the air surrounding a PV device

Note 1 to entry: Unit: °C.

[SOURCE: IEC 60050-826:2004, 826-10-03]

3.6.4

angle

Note 1 to entry: Unit: degree or radian.

3.6.4.1

angle of incidence

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

3.6.4.2

aperture angle

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

Note 1 to entry: A full angle is used occasionally instead of a half angle.

3.6.4.3**azimuth angle** 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 1 to entry: Azimuth angle is measured from due north in the southern hemisphere and from due south in the northern hemisphere.

Note 2 to entry: Negative azimuth values indicate an eastern orientation and positive values, a western orientation.

3.6.4.4**solar elevation angle** θ

angle between the direct solar beam and the horizontal plane

3.6.4.5**tilt angle**

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

3.6.5**annealing conditioning**

SEE: "conditioning/annealing conditioning", 3.6.10.1

3.6.6**aperture angle**

SEE: "angle/aperture angle", 3.6.4.2

3.6.7 Atmospheric**3.6.7.1****atmospheric ozone content**

volume of ozone at standard temperature and pressure in a vertical column of the atmosphere 1 cm² in cross section

Note 1 to entry: Unit: cm of column height.

3.6.7.2**precipitable water vapour content**

volume of precipitable water vapour in a vertical column of the atmosphere 1 cm² in cross section

Note 1 to entry: Unit: cm of column height.

3.6.7.3**atmospheric transmissivity**

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

Note 1 to entry: Unit: dimensionless, usually expressed as a percentage, %.

3.6.8**azimuth angle**

SEE: "angle/azimuth angle", 3.6.4.3

3.6.9**cell temperature factor of a photovoltaic device**

factor describing the change in the photovoltaic device output energy due to the change in its temperature

3.6.10 conditioning

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

Note 1 to entry: Conditioning is sometimes referred to as pre-conditioning.

Note 2 to entry: 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:

3.6.10.1 annealing conditioning

conditioning using a heat exposure process

3.6.10.2 light soaking conditioning

conditioning using a light exposure process

3.6.11 damp heat test

SEE: "environmental test/damp heat test", 3.6.16.1

3.6.12 diffuse irradiance

SEE: "irradiance/diffuse irradiance", 3.6.26.1

3.6.13 diffuse irradiation

SEE: "irradiation/diffuse irradiation", 3.6.27.1

3.6.14 direct irradiance

SEE: "irradiance/direct irradiance", 3.6.26.2

3.6.15 direct irradiation

SEE: "Irradiation/direct irradiation", 3.6.27.2

3.6.16 environmental test

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

Note 1 to entry: 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:

3.6.16.1 damp heat test

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

3.6.16.2 hail test

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

3.6.16.3**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

3.6.16.4**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

3.6.16.5**impact test**

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

3.6.16.6**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

3.6.16.7**mechanical load test**

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

3.6.16.8**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

3.6.16.9**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

3.6.16.10**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

3.6.16.11**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

3.6.16.12**twist test**

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

3.6.16.13**UV test**

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

3.6.16.14

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

3.6.17

global irradiance

SEE: "irradiance/global irradiance", 3.6.26.3

3.6.18

global irradiation

SEE: "irradiation/global irradiation", 3.6.27.3

3.6.19

hail test

SEE: "environmental test/hail test", 3.6.16.2

3.6.20

hot-spot endurance test

SEE: "environmental test/hot-spot endurance test", 3.6.16.3

3.6.21

humidity freeze test

SEE: "environmental test/humidity freeze test", 3.6.16.4

3.6.22

impact test

SEE: "environmental test/impact test", 3.6.16.5

3.6.23

in-plane irradiance

SEE: "irradiance/in-plane irradiance", 3.6.26.4

3.6.24

insulation test

SEE: "environmental test/insulation test", 3.6.16.6

3.6.25

integrated irradiance

SEE: "irradiance/integrated irradiance", 3.6.26.5

3.6.26

irradiance

G

electromagnetic radiated power per unit of area

Note 1 to entry: Unit: $\text{W} \cdot \text{m}^{-2}$.

Note 2 to entry: Irradiance commonly references light from the sunsolar simulator.

3.6.26.1

diffuse irradiance

irradiance excluding that portion which contributes to direct irradiance

3.6.26.2**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°)

3.6.26.3**global irradiance**

irradiance on a horizontal surface

Note 1 to entry: Global irradiance equals horizontal direct irradiance plus horizontal diffuse irradiance.

3.6.26.4**in-plane irradiance**

G_l

total irradiance on the plane of a PV device

3.6.26.5**integrated irradiance**

continuously integrated spectral irradiance over the total range of wavelengths

Note 1 to entry: 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 2 to entry: Integrated irradiance is measured by a pyranometer that can precisely respond to the spectral profile of the radiation.

3.6.26.6**plane of array irradiance**

same as in-plane irradiance

3.6.26.7**spectral irradiance**

E_λ

irradiance per unit bandwidth at a particular wavelength

Note 1 to entry: Unit: $\text{W} \cdot \text{m}^{-2} \cdot \mu\text{m}^{-1}$.

3.6.26.8**spectral photon irradiance**

$E_{p\lambda}$

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

Note 1 to entry: Unit: $\text{cm}^{-2} \cdot \text{s}^{-1} \cdot \mu\text{m}^{-1}$.

3.6.26.9**test irradiance**

G_t

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

3.6.26.10**total irradiance**

G_T

direct plus diffuse irradiance on an inclined surface

3.6.27**irradiation**

H

irradiance integrated over a specified time interval

Note 1 to entry: Unit: $\text{W} \cdot \text{m}^{-2} \cdot \mu\text{m}^{-1}$.

3.6.27.1

diffuse irradiation

diffuse irradiance integrated over a specified time interval

3.6.27.2

direct irradiation

direct irradiance integrated over a specified time interval

3.6.27.3

global irradiation

global irradiance integrated over a specified time interval

3.6.27.4

total irradiation

H_T

total irradiance integrated over a specified time interval

3.6.28

light soaking conditioning

SEE: "conditioning/light soaking conditioning", 3.6.10.2

3.6.29

maximum power temperature coefficient

δ

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

Note 1 to entry: Unit: $W \cdot K^{-1}$ (absolute), K^{-1} (relative).

Note 2 to entry: Both absolute and relative values are used.

Note 3 to entry: 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.

3.6.30

mechanical load test

SEE: "environmental test/mechanical load test", 3.6.16.7

3.6.31

outdoor exposure test

SEE: "environmental test/outdoor exposure test", 3.6.16.8

3.6.32

ozoneT content

SEE: "atmospheric/atmospheric ozone content", 3.6.7.1

3.6.33

plane of array irradiance

SEE: "irradiance/plane of array irradiance", 3.6.26.6

3.6.34

precipitable water vapour content

SEE: "atmospheric/precipitable water vapour content", 3.6.7.2

3.6.35

reference spectral irradiance distribution

SEE: "spectral irradiance distribution/reference spectral irradiance distribution", 3.6.39.1

3.6.36**robustness of terminations test**

SEE: "environmental test/robustness of terminations test", 3.6.16.9

3.6.37**salt mist test**

SEE: "environmental test/salt mist test", 3.6.16.10

3.6.38**spectral irradiance**

SEE: "irradiance/spectral irradiance", 3.6.26.7

3.6.39**spectral irradiance distribution**

spectral irradiance plotted as a function of wavelength

Note 1 to entry: Unit: $\text{W}\cdot\text{m}^{-2}\cdot\mu\text{m}^{-1}$.

3.6.39.1**reference spectral irradiance distribution**

tabulation of spectral irradiance, spectral photon irradiance and cumulative integrated irradiance versus wavelength, as defined in Table 1 of IEC 60904-3:2016

3.6.40**spectral photon irradiance**

SEE: "irradiance/spectral photon irradiance", 3.6.26.8

3.6.41**spectrum**

SEE: "solar/solar spectrum", 3.6.42.5

3.6.42**solar**

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

3.6.42.1**solar constant**

irradiance produced by extraterrestrial solar radiation on a surface normal to this radiation at the mean Sun-Earth distance

Note 1 to entry: Unit: $\text{W}\cdot\text{m}^{-2}$.

Note 2 to entry: The latest value for the solar constant is $1\,367\text{ W}\cdot\text{m}^{-2}$ adopted by the Commission for Instruments and Methods of Observation in World Meteorological Organization in 1981.

[SOURCE: IEC 60050-845:1987, 845-09-78, modified]

3.6.42.2**solar energy**

common term meaning irradiation

3.6.42.3**solar power**

common term meaning irradiance

3.6.42.4**solar radiation**

common term meaning irradiation

3.6.42.5

solar spectrum

distribution of the solar irradiation as the function of wavelength

Note 1 to entry: Unit: $\text{J}\cdot\text{m}^{-2}\cdot\mu\text{m}^{-1}$.

3.6.43

solar elevation angle

SEE: "angle/solar elevation angle", 3.6.4.4

3.6.44

test irradiance

SEE: "irradiance/test irradiance", 3.6.26.9

3.6.45

thermal cycling test

SEE: "environmental test/thermal cycling test", 3.6.16.11

3.6.46

tilt angle

SEE: "angle/tilt angle", 3.6.4.5

3.6.47

total irradiance

SEE: "irradiance/total irradiance", 3.6.26.10

3.6.48

total irradiation

SEE: "irradiation/total irradiation", 3.6.27.4

3.6.49

transmissivity

SEE: "atmospheric/atmospheric transmissivity", 3.6.7.3

3.6.50

turbidity

$a_{\text{D}, \lambda}$

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

Note 1 to entry: Unit: μm .

3.6.51

twist test

SEE: "environmental test/twist test", 3.6.16.12

3.6.52

UV test

SEE: "environmental test/UV test", 3.6.16.13

3.6.53

wet leakage current test

SEE: "environmental test/wet leakage current test", 3.6.16.14

3.6.54**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

[SOURCE: IEC 60050-151:2001, 151-16-23]

3.7.2**applicant**

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

[SOURCE: IEC 60050-311:2001, 311-01-09]

3.7.4**cell manufacturer**

SEE: "manufacturer/cell manufacturer", 3.7.15.1

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

3.7.6.1**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

3.7.6.2**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

3.7.6.3**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 1 to entry: 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.

3.7.6.4

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

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 1 to entry: 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

3.7.8.1

conformity evaluation

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

Note 1 to entry: Conformity evaluation is also known as Conformity Assessment.

Note 2 to entry: Conformity Assessment is necessary to ensure that a quality system is in place that ensures that the product or system configuration does not change from that which was tested.

3.7.8.2

conformity surveillance

evaluation for conformity to determine the continuing conformity with specified requirements

3.7.9

delamination

unintentional separation of layers in a laminate creating a potential loss of module performance, long-term durability or other damage

3.7.10

inspection

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

3.7.10.1

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

3.7.10.2

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 1 to entry: An inspection body may be the functional arm of a certification body.

3.7.11

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

3.7.12 Laboratory

3.7.12.1

testing laboratory

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

Note 1 to entry: 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.

3.7.12.2

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

3.7.13

licensee <for certification>

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

3.7.14

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

3.7.15

manufacturer

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

3.7.15.1

cell manufacturer

organisation carrying out the manufacture of PV cells

3.7.15.2

module manufacturer

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

3.7.16

memorandum of understanding

MOU

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

3.7.17

module manufacturer

SEE: "manufacturer/module manufacturer", 3.7.15.2