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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Template for comments and secretariat observations

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



82/1741/CD

COMMITTEE DRAFT (CD)

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SECRETARIAT:

United States of America

SECRETARY:

Mr George Kelly

OF INTEREST TO THE FOLLOWING COMMITTEES:

PROPOSED HORIZONTAL STANDARD:

☐

Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☐ EMC

☐ ENVIRONMENT

☒ QUALITY ASSURANCE

☒ SAFETY

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Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:

Photovoltaic (PV) systems - Requirements for testing, documentation and maintenance - Part 1: Grid connected systems - Documentation, commissioning tests and inspection

NOTE FROM TC/SC OFFICERS:

This project was discussed and supported by WG3 during their remote meeting in 2020-04.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**PHOTOVOLTAIC (PV) SYSTEMS – REQUIREMENTS FOR TESTING,
DOCUMENTATION AND MAINTENANCE –****Part 1: Grid connected systems – Documentation,
commissioning tests and inspection****FOREWORD**

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This Consolidated version of IEC 62446-1 bears the edition number 1.1. It consists of the first edition (2016-01) [documents 82/1036/FDIS and 82/1056A/RVD] and its amendment 1 (2018-08) [documents 82/1415/FDIS and 82/1426/RVD]. The technical content is identical to the base edition and its amendment.

This Final version does not show where the technical content is modified by amendment 1. A separate Redline version with all changes highlighted is available in this publication.

170 International Standard IEC 62446-1 has been prepared by IEC technical committee 82: Solar
171 photovoltaic energy systems.

172 This second edition constitutes a technical revision.

173 This edition includes the following significant technical change with respect to
174 IEC 62446:2016:

175 – To be written at later stage in drafting

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

177 A list of all parts in the IEC 62446 series, published under the general title *Photovoltaic (PV)*
178 *systems – Requirements for testing, documentation and maintenance*, can be found on the
179 IEC website.

180 The committee has decided that the contents of the base publication and its amendment will
181 remain unchanged until the stability date indicated on the IEC web site under
182 "http://webstore.iec.ch" in the data related to the specific publication. At this date, the
183 publication will be

- 184 • reconfirmed,
- 185 • withdrawn,
- 186 • replaced by a revised edition, or
- 187 • amended.

188

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190

INTRODUCTION

Grid connected PV systems are expected to have a lifetime of decades, with maintenance or modifications likely at some point over this period. Building or electrical works in the vicinity of the PV array are very likely, for example roof works adjacent to the array or modifications (structural or electrical) to a home that has a PV system. The ownership of a system may also change over time, particularly for systems mounted on buildings. Only by the provision of adequate documentation at the outset can the long term performance and safety of the PV system and works, on or adjacent to the PV system, be ensured.

This part of IEC 62446 is split into two sections:

- **System documentation requirements** – This section details the information that shall be provided within the documentation provided to the customer following installation of a grid connected PV system.
- **Verification** – This section provides the information expected to be provided following initial (or periodic) verification of an installed system. It includes requirements for inspection and testing.

PHOTOVOLTAIC (PV) SYSTEMS – REQUIREMENTS FOR TESTING, DOCUMENTATION AND MAINTENANCE –

Part 1: Grid connected systems – Documentation, commissioning tests and inspection

1 Scope

This part of IEC 62446 defines the information and documentation required to be handed over to a customer following the installation of a grid connected PV system. It also describes the commissioning tests, inspection criteria and documentation expected to verify the safe installation and correct operation of the system. It can also be used for periodic retesting.

This part of IEC 62446 is for use by system designers and installers of grid connected solar PV systems as a template to provide effective documentation to a customer. By detailing the expected commissioning tests and inspection criteria, it is also intended to assist in the verification/inspection of a grid connected PV system after installation and for subsequent re-inspection, maintenance or modifications.

This part of IEC 62446 defines the different test regimes expected for different solar PV system types to ensure that the test regime applied is appropriate to the scale, type and complexity of the system in question.

Safety requirements for systems incorporating a DC coupled battery are included in the scope of this document.

Note 1: Batteries may also be AC coupled to a PV system, but as such are considered out of the scope of this document

NOTE 2: This document does not address off-grid systems, hybrid systems, or concentrating PV systems, however many of the parts may apply.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60364-6, *Low-voltage electrical installations – Part 6: Verification*

IEC 62548:20XX, *Photovoltaic (PV) arrays – Design requirements*

NOTE In some countries IEC 60364 including IEC 60364-7-712 is preferred over IEC 62548. Both standards are expected to provide similar results.

IEC 61730 (all parts), *Photovoltaic (PV) module safety qualification*

IEC 61557 (all parts), *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures*

IEC 61010 (all parts), *Safety requirements for electrical equipment for measurement, control, and laboratory use*

IEC 60891:2009, *Photovoltaic devices – Procedures for temperature and irradiance corrections to measured I-V characteristics*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

AC module

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

3.2 Bifacial PV device

in a bifacial PV device, both surfaces (front and back sides) of the PV module are used for power generation.

3.3

cable type

description of a cable to enable its rating and suitability for a particular use or environment to be determined

Note 1 to entry: In many countries this is done via a code number (eg "H07RNF").

3.4

data sheet

basic product description and specification

Note 1 to entry: Typically one or two pages. Not a full product manual.

3.5

inspection

examination of an electrical installation using all the senses in order to ascertain correct selection and proper erection of electrical equipment

3.6

inverter

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

3.7

K_I

DC current rating adjustment factor dependent on site PV module type and installation properties such as module orientation, module shading or module rear side irradiance.

Note 1 to entry: See IEC 62548 for calculation of k_I .

3.8

micro inverter

small inverter designed to be connected directly to one or two PV modules.

Note 1 to entry: A micro inverter will normally connect directly to the factory fitted module leads and be fixed to the module frame or mounted immediately adjacent to the module.

3.9

module integrated electronics

any electronic device fitted to a PV module intended to provide control, monitoring or power conversion functions

Note 1 to entry: Module integrated electronics may be factory fitted or assembled on site.

Note 2 to entry: a microinverter may sometimes also be a module integrated electronic device

3.10

PV array

An assembly of electrically interconnected PV modules, PV strings or PV sub-arrays.

3.11**PV cell**

The most elementary device within a PV module that exhibits the photovoltaic effect, i.e the direct non-thermal conversion of radiant energy into electrical energy

3.12**PV module**

The smallest complete environmentally protected assembly of interconnected PV cells

3.13**PV string**

A circuit of one or more series-connected PV modules

3.14**PV string combiner box**

junction box where PV strings are connected, which may also contain overcurrent protection devices, electronics and/or switch-disconnectors

3.15**PV sub array**

electrical subset of a PV array formed of parallel connected PV strings

3.16**PV sub-array combiner box**

junction box where PV sub-arrays are connected, which may also contain overcurrent protection devices, electronics and/or switch-disconnectors

3.17 **$I_{MOD_MAX_OCPR}$**

PV module maximum overcurrent protection rating determined by IEC 61730-2

Note 1 to entry: This is often specified by module manufacturers as the maximum series fuse rating.

3.18**reporting**

recording of the results of inspection and testing

3.19**testing**

implementation of measures in an electrical installation by means of which its effectiveness is proved

Note 1 to entry: It includes ascertaining values by means of appropriate measuring instruments, said values not being detectable by inspection.

3.20**verification**

all measures by means of which compliance of the electrical installation to the relevant standards is checked

Note 1 to entry: It comprises inspection, testing and reporting.

3.21**string wiring harness**

prefabricated cable assembly that aggregates the output of multiple PV string conductors along a single main cable

Note 1 to entry: The harness may or may not include fusing on the individual string conductors. The wiring harness typically does not include a disconnect device in line.

Note 2 to entry: An IEC standard for string wiring harnesses is under development.

3.22**Harness Sub Array****HSA**

group of PV strings connected in parallel using a string wiring harness

Note 1 to entry: For the purposes of this document, the HSA shall have a combined I_{SC-STC} of no greater than 30 A and combine no more than 10 PV strings.

Note 2 to entry: In some subclauses of this document, HSA tests are presented as an alternative to individual string tests. The 30 A and 10 string limits defined herein set the limit where a HSA test is considered a safe and valid alternative to individual string tests.

Note 3 to entry: This note applies to the French language only.

3.23**module-level-monitoring (MLM)**

Device or equipment used at module level to monitor at least power and voltage at module level

Note 1 to entry: Microinverter and DC-DC converters on module-level typically include such functionality

3.24**Shutdown equipment**

Equipment to de-energize parts of the PV array or the whole PV array by either isolation or disconnection in case of an a.c. disconnection or by manual remote control

Note to entry: In some countries such equipment is described as "rapid shutdown" equipment for emergency services

4 System documentation requirements**4.1 General**

The purpose of Clause 4 is to list the minimum documentation that should be provided following the installation of a grid connected PV system. This information will ensure key system data is readily available to a customer, inspector or maintenance engineer. The documentation includes basic system data and the information expected to be provided in the operation and maintenance manual.

4.2 System Information**4.2.1 Basic system information**

As a minimum, the following basic system information shall be provided. This "nameplate" information would typically be presented on the cover page of the system documentation pack.

- a) Project identification reference (where applicable);
- b) Rated (nameplate) system power (kW DC or kVA AC);
- c) PV modules and inverters – manufacturer, model and quantity;
- d) Installation date;
- e) Customer name;
- f) Site address.

NOTE: While full information will be available from the module data sheet(s), listing additional power ratings should be considered for systems using Bifacial modules.

4.2.2 System designer information

As a minimum, the following information shall be provided for all bodies responsible for the design of the system. Where more than one company has responsibility for the design of the system, the following information should be provided for all companies together with a description of their role in the project.

- a) System designer, company;

- b) System designer, contact person;
c) System designer, postal address, telephone number and e-mail address.

The standard(s) to which the system has been designed shall also be provided. This information shall include the document number, title and year of issue.

4.2.3 System installer information

As a minimum, the following information shall be provided for all bodies responsible for the installation of the system. Where more than one company has responsibility for the installation of the system, the following information should be provided for all companies together with a description of their role in the project.

- a) System installer, company;
b) System installer, contact person;
c) System installer, postal address, telephone number and e-mail address.

4.3 Wiring diagram

4.3.1 General

As a minimum, a single line wiring diagram shall be provided. This diagram shall be annotated to include the information detailed in 4.3.2 to 4.3.6.

In general, it is expected that this information will be presented as annotations to the single line wiring diagram. In some circumstances, typically for larger systems where space on the diagram may be limited, this information may be presented in table form.

4.3.2 Array – General specifications

The wiring diagram or system specification shall include the following array design information.

- a) Module manufacturer and model
b) Total number of modules;
c) The DC current rating adjustment factor, K_i , used in all sizing calculations
d) General string configuration, including:
- Number of modules per string. Where applicable, this should include clear identification of strings of differing lengths;
- Number of strings per inverter
- Identification of which strings connect to which inverter
- Identification of any inverter with differing number of strings
e) Where a system includes module-level electronics (eg DC-DC convertors):
- Manufacturer and model
- Connection to PV modules
f) Inverter manufacturer and model
g) Total number of inverters

Where an array is split into sub-arrays, the wiring diagram shall show the array - sub-array design and include all of the above information for each sub-array.

4.3.3 PV string information

The wiring diagram or system specification shall include the following PV string information.

- a) PV string cable specifications – size and type / ratings
b) PV string overcurrent protective device specifications (where fitted) – type and voltage/current ratings;

c) Blocking diode type (if relevant).

4.3.4 PV array electrical details

The wiring diagram or system specification shall include the following array / sub-array, electrical information (where fitted).

a) PV string and PV sub-array combiner box – location;

b) PV array cable specifications – size and type / ratings;

c) DC switch disconnecter - location and rating;

d) Array overcurrent protective devices – type, location and rating

e) Other array protective circuitry (such as arc fault detection or ground fault protection) – type, location and rating;

Rating information shall include DC voltage and current ratings

4.4 String layout

For systems with three or more strings, and optionally for smaller systems, a string layout drawing of the PV system showing how the array is split and connected into strings shall be provided. From the string layout, it shall be possible to trace modules in the array to their respective string and inverter, and vice versa.

For large systems, a physical layout including the string layout and the location of inverters, any major pieces of equipment, and key access concerns should be included.

NOTE This is particularly useful for finding faults in larger systems and on building mounted arrays where access to the modules is difficult

4.5 AC system

The wiring diagram or system specification shall include the following AC system information.

a) AC isolator location, type and rating;

b) AC overcurrent protective device location, type and rating;

c) Residual current device location, type and rating (where fitted).

Rating information shall include AC voltage and current ratings

4.6 Earthing and overvoltage protection

The wiring diagram or system specification shall include the following earthing and overvoltage protection information.

a) Details of all earth bonding conductors – size and type; Including details of array frame equipotential bonding cables, where fitted.

b) Details of any connections to a Lightning Protection System (LPS);

c) Details of any surge protection device installed (on both AC and DC lines) - location, type and rating.

4.7 Anti-PID systems

The type, location and rating of Anti-PID systems shall be documented, where fitted.

Operating information shall also be provided, including:

a) The times of the day the system is operational

b) The voltage present during operation