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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Concentrator photovoltaic (CPV) modules and assemblies – Design qualification and type approval

Modules et ensembles photovoltaïques à concentration – Qualification de la conception et homologation

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CONCENTRATOR PHOTOVOLTAIC (CPV) MODULES AND ASSEMBLIES – DESIGN QUALIFICATION AND TYPE APPROVAL

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International Standard IEC 62108 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this standard is based on the following documents:

FDIS	Report on voting
82/494/FDIS	82/504/RVD

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

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

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

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- withdrawn,
- replaced by a revised edition, or
- amended.

CONCENTRATOR PHOTOVOLTAIC (CPV) MODULES AND ASSEMBLIES – DESIGN QUALIFICATION AND TYPE APPROVAL

1 Scope and object

This International Standard specifies the minimum requirements for the design qualification and type approval of concentrator photovoltaic (CPV) modules and assemblies suitable for long-term operation in general open-air climates as defined in IEC 60721-2-1. The test sequence is partially based on that specified in IEC 61215 for the design qualification and type approval of flat-plate terrestrial crystalline silicon PV modules. However, some changes have been made to account for the special features of CPV receivers and modules, particularly with regard to the separation of on-site and in-lab tests, effects of tracking alignment, high current density, and rapid temperature changes, which have resulted in the formulation of some new test procedures or new requirements.

The object of this test standard is to determine the electrical, mechanical, and thermal characteristics of the CPV modules and assemblies and to show, as far as possible within reasonable constraints of cost and time, that the CPV modules and assemblies are capable of withstanding prolonged exposure in climates described in the scope. The actual life of CPV modules and assemblies so qualified will depend on their design, production, environment, and the conditions under which they are operated.

2 Normative references

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

IEC 60068-2-21:2006, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*

IEC 61215:2005, *Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval*

ISO/IEC 17025:2005, *General requirements for the competence of testing and calibration laboratories*

ANSI/UL 1703 ed.3 March 15, 2002: *Flat-Plate Photovoltaic Modules and Panels*

3 Terms and definitions

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

3.1
concentrator
term associated with photovoltaic devices that use concentrated sunlight

3.2
concentrator cell
basic photovoltaic device that is used under the illumination of concentrated sunlight

3.3
concentrator optics
optical device that performs one or more of the following functions from its input to output: increasing the light intensity, filtering the spectrum, modifying light intensity distribution, or changing light direction. Typically, it is a lens or a mirror. A **primary optics** receives unconcentrated sunlight directly from the sun. A **secondary optics** receives concentrated or modified sunlight from another optical device, such as primary optics or another secondary optics.

3.4
concentrator receiver
group of one or more concentrator cells and secondary optics (if present) that accepts concentrated sunlight and incorporates the means for thermal and electric energy transfer. A receiver could be made of several **sub-receivers**. The sub-receiver is a physically stand-alone, smaller portion of the full-size receiver.

3.5
concentrator module
group of receivers, optics, and other related components, such as interconnection and mounting, that accepts unconcentrated sunlight. All of the above components are usually prefabricated as one unit, and the focus point is not field adjustable. A module could be made of several **sub-modules**. The sub-module is a physically stand-alone, smaller portion of the full-size module.

3.6
concentrator assembly
group of receivers, optics, and other related components, such as interconnection and mounting, that accepts unconcentrated sunlight. All of the above components would usually be shipped separately and need some field installation, and the focus point is field adjustable. An assembly could be made of several **sub-assemblies**. The sub-assembly is a physically stand-alone, smaller portion of the full-size assembly.

3.7
representative samples for CPV
see details in Clause 4

Figures from Figures 1 to 5 are schematics of cells, receivers, modules, and assemblies.

Table 1 – Terms used for CPVs

Primary optics		**CPV Module** – prefabricated and the focus point is not field adjustable, similar to most Fresnel lens systems. **CPV Assembly** – needs some field installation and the focus point is field adjustable, similar to most reflective systems.
Secondary optics	CPV receiver	
CPV cells		
Electric energy transfer means		
Thermal energy transfer means		
Interconnection		
Mounting		

4 Sampling

For non-field-adjustable focus-point CPV systems or modules, 7 modules and 2 receivers are required to complete all the specified tests, plus one receiver for the bypass/blocking diode thermal test (intrusive or non-intrusive). For details, see Figure 6. For field-adjustable focus-point CPV systems or assemblies, 9 receivers (including secondary optics sections, if applicable) and 7 primary optics sections are required to complete all the specified tests, plus one receiver for the bypass/blocking diode thermal test (intrusive or non-intrusive). For details, see Figure 7.

In the case that a full-size module or assembly is too large to fit into available testing equipment, such as environmental chambers, or a full-size module or assembly is too expensive (e.g., for a 20 kW reflective dish concentrator system, 9 receiver samples account for 180 kW of PV cells), a smaller representative sample may be used. However, even if representative samples are used for the other test, a full-size module or assembly should be installed and tested for outdoor exposure. This can be conducted either in the testing lab, or through on-site witness.

Representative samples should include all components, except some repeated parts. If possible, the representative samples should use sub-receivers, sub-modules, or sub-assemblies. During the design and manufacturing of the representative samples, much attention should be paid to reach the maximum similarity to the full-size component in all electrical, mechanical, and thermal characteristics related to quality and reliability.

Specifically, the cell string in representative samples should be long enough to include at least two bypass diodes, but in no case less than ten cells. The encapsulations, interconnects, terminations, and the clearance distances around all edges should be the same as on the actual full-size products. Other representative components, including lens/housing joints, receiver/housing joints, and end plate/lens should also be included and tested.

Test samples should be taken at random from a production batch or batches. When the samples to be tested are prototypes of a new design and not from production, or representative samples are used, these facts should be noted in the test report (see Clause 8).

The test samples should have been manufactured from specified materials and components in accordance with the relevant drawings and process instructions and should have been subjected to the manufacturer's normal inspection, quality control, and production acceptance procedures. They should be complete in every detail and should be accompanied by the manufacturer's handling, mounting, connection, and operation manuals. Samples should not be subjected to other special procedures that are not a part of standard production.

If the intrusive bypass/blocking diode thermal test is to be performed, an additional specially manufactured receiver is required with extra electrical and thermal detector leads so that each individual diode can be accessed separately.

5 Marking

Each receiver or module section should carry the following clear and indelible markings:

- name, monogram, or symbol of manufacturer;
- type or model number;
- serial number;
- polarity of terminals or leads (color coding is permissible);
- maximum system voltage for which the module or assembly is suitable;
- nominal maximum output power and its tolerance at specified condition;
- the date, place of manufacture, and cell materials should be marked, or be traceable from the serial number.

If representative samples are used, the same markings as on full-size products should be included for all tests, and the marking should be capable of surviving all test sequences.

6 Testing

Before beginning the testing, all testing samples, including the control module and control receiver, should be exposed to the direct normal irradiation (DNI) of sunlight (either natural or simulated) for a total of 5 to 5,5 kWh/m^2 while open-circuited. This procedure is designed to reduce the initial photon degradation effects.

In this standard, short-circuit current I_{sc}, open-circuit voltage V_{oc}, maximum output power P_m, and other measures are all based on DNI 900 W/m^2, cell temperature 25 °C, spectrum at Air Mass 1,5D (under consideration), and wind speed 3 m/s. A formal Concentrator Standard Test Condition (CSTC) definition will be given in a future IEC CPV standard, which is under consideration.

The test samples should be randomly divided into groups and subjected to the qualification test sequences in Figure 6 or Figure 7. Test procedures and requirements are detailed in Clause 10, and summarized in Annex A. The allocation of test samples to typical test sequences is given in Table 2.

After initial tests and inspections, one module or one receiver/mirror section should be removed from the test sequence as a control unit. Preferably, the control unit should be stored in the dark at room temperature to reduce the electrical performance degradation, but it may be kept outdoors with a dark cover. As shown in Figure 6 for modules or in Figure 7 for assemblies, the test sequence is performed both in-lab and on-site. If the distance between these two locations is considerable or public shipping companies are involved, a dark current-voltage (I-V) curve measurement before and after the shipping should be performed to evaluate any possible changes on testing samples.

If a particular manufacturer produces only specific components, such as receivers, lenses, or mirrors, the design qualification and type approval testing may be conducted only on applicable test sequences, and a partial certification can be issued independently.

If some test procedures in this standard are not applicable to a specific design configuration, the manufacturer should discuss this with the certifying body and testing agency to develop a comparable test program, based on the principles described in this standard. Any changes and deviations shall be recorded and reported in details, as required in Clause 8, item j).

Table 2 – Allocation of test samples to typical test sequences

Test sequence	Module		Assembly	
	receiver	module	receiver	mirror
Control		1	1	1
A	2		2	
B		2	2	2
C		2	2	2
D		1	1	1
E		1 (full-size)	1 (full-size)	1 (full-size)
F	1		1	
Total	3	7	10	7

7 Pass criteria

A concentrator photovoltaic module or assembly design should be judged to have passed the qualification tests, and therefore to be IEC 62108 type approved, if each test sample meets all the following criteria:

a) the relative power degradation in sequences A to D does not exceed 13 % if the I-V measurement is under outdoor natural sunlight, or 8 % if the I-V measurement is under solar simulator;

b) the relative power degradation in sequence E does not exceed 7 % for natural sunlight I-V measurement, or 5 % for solar simulator I-V measurement, because the 1 000 kWh/m^2 DNI outdoor exposure and 50 kWh/m^2 ultraviolet (UV) tests are not an accelerated stress test;

c) no sample has exhibited any open circuit during the tests;

d) there is no visual evidence of a major defect, as defined in 10.1.2;

e) the insulation test requirements are met at the beginning and the end of each sequence;

f) the wet leakage current test requirements are met at the beginning and the end of each sequence;

g) specific requirements of the individual tests are met.

If there are some failures observed during the test, the following judgment and re-test procedure should apply:

h) if two or more test samples do not meet pass criteria, the design shall be deemed not to have met the qualification requirements;

i) should one sample fail any test, another two samples meeting the requirements of Clause 4 could be subjected to the whole of the relevant test sequence from the beginning;

j) in case i), if both samples pass the test sequence, the design should be judged to have met the qualification requirements;

k) in case i), if one or both of these samples also fail, the design shall be deemed not to have met the qualification requirements;

l) in case h) or k), the entire test program illustrated in Figure 6 or Figure 7 should be re-performed, usually after some design or processing improvement.

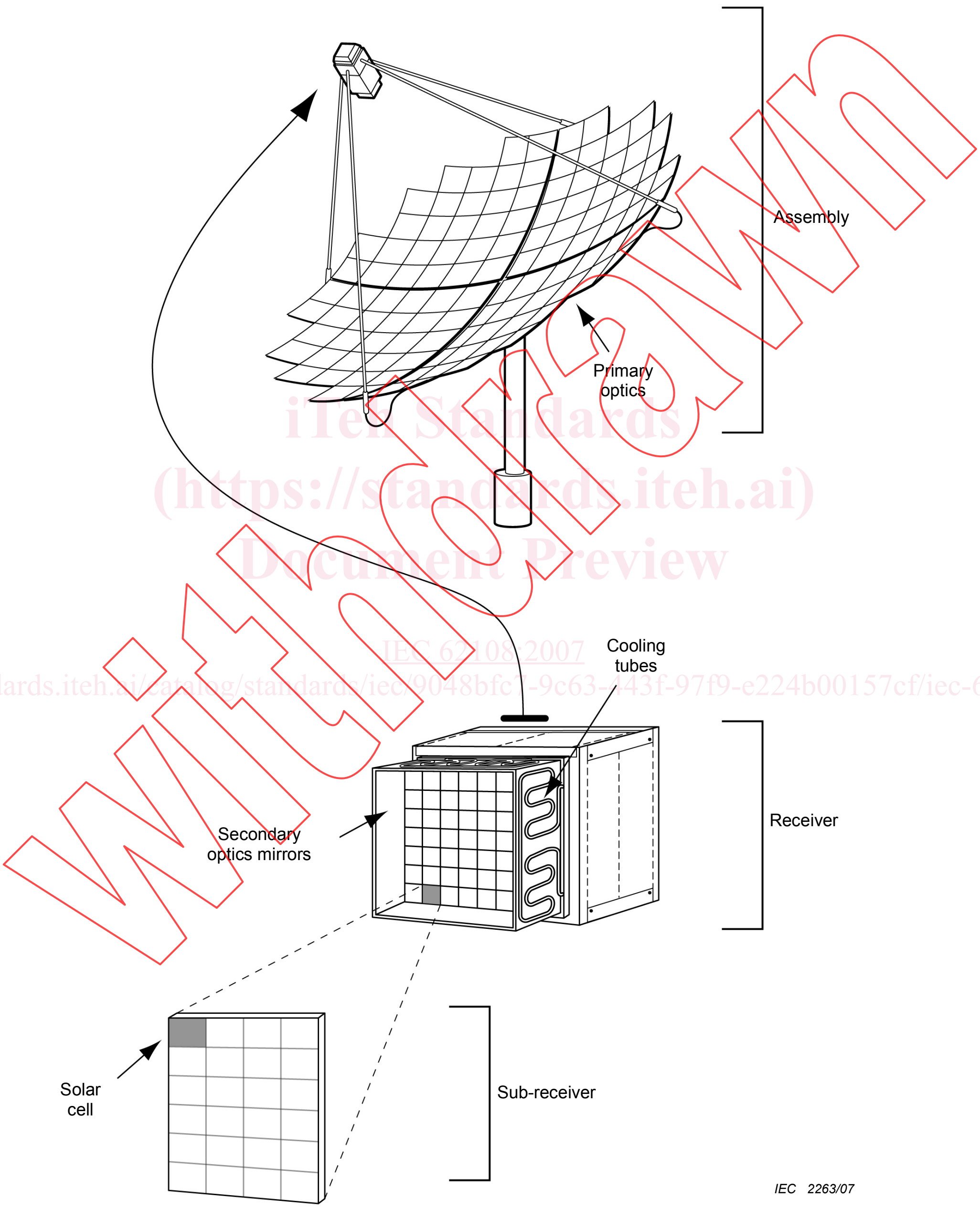

Figure 1 – Schematic of point-focus dish PV concentrator

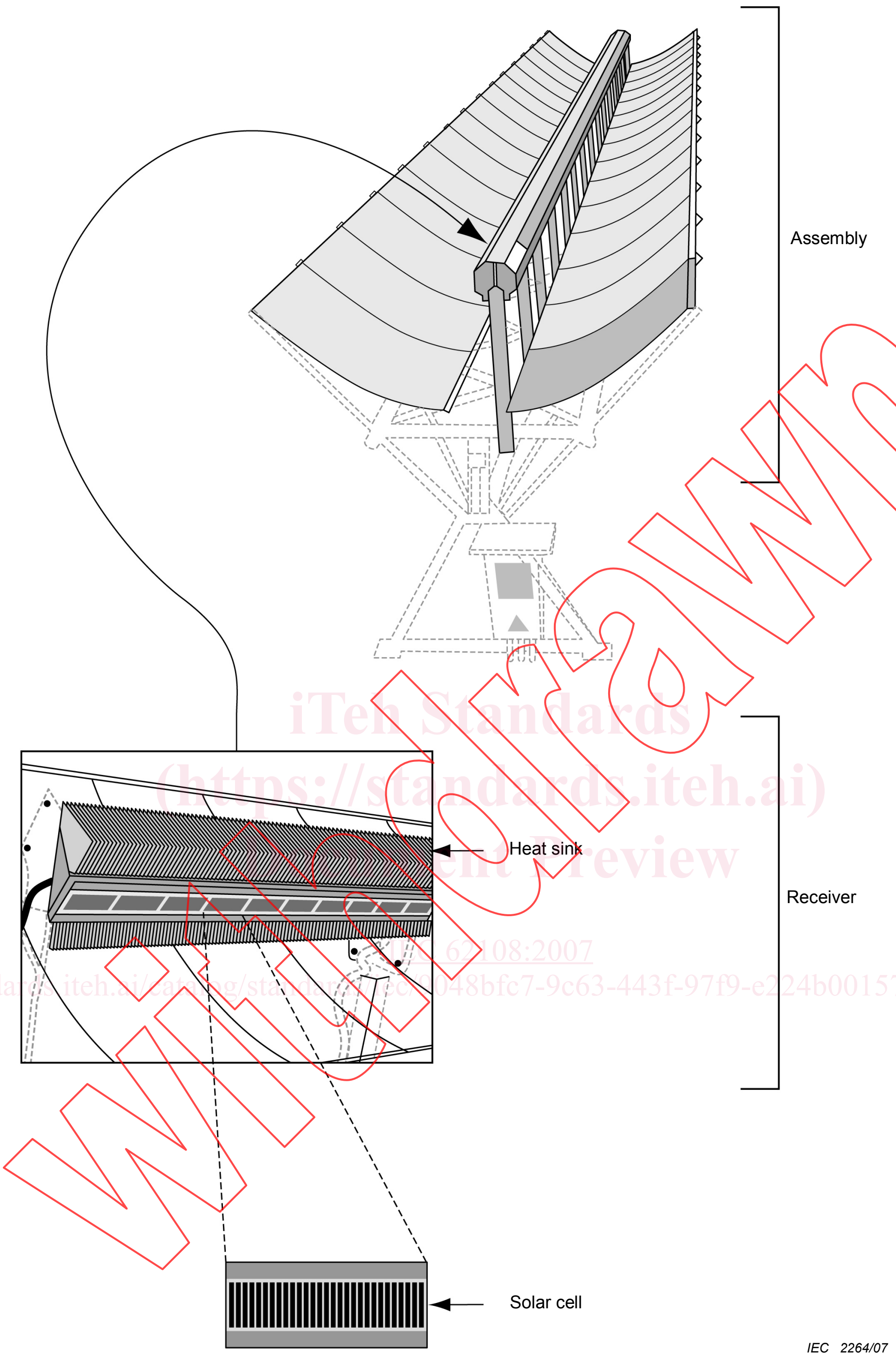

Figure 2 – Schematic of linear-focus trough PV concentrator