



DPC: 22/30446848 DC

BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

Date: 31 January 2022

Origin: International

Latest date for receipt of comments: 16 February 2022

Project No. 2021/03040

Responsible committee: GEL/82 Photovoltaic Energy Systems

Interested committees:

Title: Draft BS EN 62688 Ed.2.0 Concentrator photovoltaic (CPV) modules and assemblies - Safety qualification.

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

- i) has any issues related to 3rd party IPR, patent or copyright
- ii) affects other national standard(s)
- iii) requires additional national guidance or information

WARNING: THIS IS A DRAFT AND MUST NOT BE REGARDED OR USED AS A BRITISH STANDARD. THIS DRAFT IS NOT CURRENT BEYOND 16 February 2022

This draft is issued to allow comments from interested parties; all comments will be given consideration prior to publication. No acknowledgement will normally be sent. **See overleaf for information on the submission of comments.**

No copying is allowed, in any form, without prior written permission from BSI except as permitted under the Copyright, Designs and Patent Act 1988 or for circulation within a nominating organization for briefing purposes. Electronic circulation is limited to dissemination by e-mail within such an organization by committee members.

Further copies of this draft may be purchased from BSI Shop <http://shop.bsigroup.com> or from BSI Customer Services, Tel: +44(0) 20 8996 9001 or email cservices@bsigroup.com. British, International and foreign standards are also available from BSI Customer Services.

Information on the co-operating organizations represented on the committees referenced above may be obtained from <https://standardsdevelopment.bsigroup.com/>.

Responsible Committee Secretary: Ms Louisa Mohsen (BSI)

Direct tel: 020 8996 7230

E-mail: louisa.mohsen@bsigroup.com

Full document details: 22/30446848 DC

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.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
------------------	------------------------

1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (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.	

PROJECT NUMBER: IEC 62688 ED2	
DATE OF CIRCULATION: 2022-01-21	CLOSING DATE FOR COMMENTS: 2022-03-18
SUPERSEDES DOCUMENTS: 82/1968/RR	

IEC TC 82 : SOLAR PHOTOVOLTAIC ENERGY SYSTEMS	
SECRETARIAT: United States of America	SECRETARY: Mr George Kelly
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 64	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	

This document is still under study and subject to change. It should not be used for reference purposes.

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: Concentrator photovoltaic (CPV) modules and assemblies – Safety qualification
--

NOTE FROM TC/SC OFFICERS: This project was discussed and supported by WG 7 during their remote meeting in 2021-11.

CONTENTS

FOREWORD	8
1 Scope	10
2 Normative references	10
3 Terms and definitions	12
4 Sampling.....	14
5 Marking.....	20
5.1 Nameplate.....	20
5.2 Hazards	20
5.2.1 High intensity light	20
5.2.2 Field connections	20
5.2.3 Hot surfaces	21
6 Report.....	21
7 Requirements for construction – Module application classes	22
7.1 General.....	22
7.2 Class II – general access, hazardous voltage, current and power, double insulated/reinforced insulation	22
7.2.1 Electrical output	22
7.2.2 Protection	23
7.2.3 Application	23
7.3 Class 0 – Restricted access, hazardous voltage, current and power basic insulation only with no protection from faults	23
7.3.1 Electrical output.....	23
7.3.2 Protection	23
7.3.3 Application	23
7.4 Class 0-X – additional concentrated light hazard	23
7.5 Class III – general access limited voltage, current and power.....	23
7.5.1 Electrical output.....	23
7.5.2 Protection	23
7.5.3 Application	24
8 Construction	24
9 Modifications.....	24
10 Requirements for supplied documents	24
10.1 General.....	24
10.2 Electrical.....	24
10.3 Mechanical.....	24
10.4 Temperature	24
10.5 Field assembly	25
10.6 Component ratings	25
11 Overcurrent protection	25
12 Metal parts.....	25
12.1 Combinations of metals	25
12.2 Corrosion protection.....	25
12.3 Edges.....	26
13 Polymeric materials.....	26
13.1 General	26

13.1.1	Overview	26
13.1.2	Solid insulation and cemented joints	26
13.1.3	Requirements for polymers	26
13.1.4	Operational categories for CPV modules and assemblies.....	28
13.2	Polymers serving as an enclosure for live parts (such as a junction box, connector, or plug)	28
13.3	Polymers serving in direct support of live parts (such as integrated terminals and potting compounds).....	28
13.4	Polymers serving as an outer surface of a receiver (such as a front sheet or back sheet on a flat-plate profile receiver in a medium-X assembly)	29
13.5	Polymers serving as an internal electrical barrier providing the sole insulation between live parts	29
13.6	Polymers serving as encapsulants.....	29
13.7	Polymers serving as adhesives for attachment (such as for a junction box)	30
13.8	Polymers serving as moisture barriers (such as edge sealants).....	30
13.9	Polymers serving as gaskets or seals (such as with front glass)	30
13.10	Polymers serving as frames (such as with flat-plate profile medium-concentration receivers).....	30
13.11	Polymers serving as CPV optics	30
13.12	Polymers exposed to sunlight, serving as a mechanical support, not functioning in categories 13.2 to 13.11	30
13.13	Polymers exposed to concentrated sunlight.....	30
14	Internal wiring and current-carrying parts	31
14.1	General	31
14.2	Internal wiring	31
14.3	Splices	31
14.4	Mechanical securement.....	31
15	Connections.....	31
15.1	Field connections – general requirements	31
15.2	Field wiring terminals	31
15.3	Connectors.....	32
15.4	Output lead or cables	32
16	Bonding and grounding	33
16.1	General	33
16.2	Lightning Protection	33
17	Protection against electric shock and energy hazards	34
17.1	General	34
17.2	Fault conditions	34
17.3	Protection against electric shock	34
17.3.1	General.....	34
17.3.2	Module Classification	34
17.3.3	Creepage and clearance distances	35
17.3.4	Degrees of pollution in the micro-environment.....	38
17.3.5	Cemented joints	38
18	Field wiring compartments with covers	40
18.1	General	40
18.2	Strain relief	40
18.3	Sharp edges.....	40
18.4	Conduit applications – Metallic	40
18.5	Conduit applications – Non-metallic.....	40

19	Requirements for testing – Test categories	42
19.1	General	42
19.2	Preconditioning tests	42
19.3	General inspection	42
19.4	Electrical shock hazard	42
19.5	Mechanical stress	43
20	Testing	44
20.1	General	44
20.2	Visual inspection	49
20.2.1	General	49
20.2.2	Requirements	49
20.3	Accessibility test	50
20.3.1	Purpose	50
20.3.2	Apparatus	50
20.3.3	Procedure	50
20.3.4	Requirements	50
20.4	Grounding/Bonding path continuity test	50
20.4.1	Purpose	50
20.4.2	Procedure	50
20.4.3	Requirements	50
20.5	Dielectric voltage withstand test	50
20.5.1	Purpose	50
20.5.2	Procedure	51
20.5.3	Requirements	51
20.6	Wet insulation test	51
20.6.1	Purpose	51
20.6.2	Procedure	51
20.6.3	Requirements	51
20.7	Reverse current overload	52
20.7.1	Purpose	52
20.7.2	Procedure	52
20.7.3	Requirements	52
20.8	Thermal cycling	52
20.8.1	General	52
20.8.2	Purpose	52
20.8.3	Procedure	53
20.8.4	Requirements	53
20.9	Humidity freeze	53
20.9.1	General	53
20.9.2	Purpose	53
20.9.3	Procedure	53
20.9.4	Requirements	53
20.10	Damp heat	53
20.10.1	General	53
20.10.2	Purpose	53
20.10.3	Procedure	53
20.10.4	Requirements	54
20.11	Bypass diode thermal	54
20.11.1	Purpose	54

20.11.2	Special test sample.....	54
20.11.3	Procedure	54
20.11.4	Requirements	54
20.12	Hot spot endurance	54
20.12.1	General.....	54
20.12.2	Procedure	54
20.12.3	Requirements	55
20.13	Off-axis beam damage	55
20.13.1	General.....	55
20.13.2	Purpose	55
20.13.3	Special case	55
20.13.4	Procedure	55
20.13.5	Requirements	55
20.14	Dust and water ingress protection test.....	55
20.14.1	General.....	55
20.14.2	Purpose	55
20.14.3	Procedure	55
20.14.4	Requirements	56
20.15	Mechanical load	56
20.15.1	Purpose	56
20.15.2	Procedure	56
20.15.3	Requirements	56
20.16	Robustness of terminations	57
20.16.1	Purpose	57
20.16.2	Types of terminations.....	57
20.16.3	Procedure	57
20.16.4	Requirements	57
20.17	Impulse voltage	57
20.17.1	Purpose	57
20.17.2	Requirements	58
20.18	CPV Temperature test.....	58
20.18.1	Purpose	58
20.18.2	Test apparatus.....	59
20.18.3	Procedure	59
20.18.4	Requirements	60
20.19	CPV electrical parameters.....	60
20.19.1	General.....	60
20.19.2	Maximum open-circuit voltage	60
20.19.3	Maximum short-circuit current	61
20.20	Outdoor exposure.....	61
20.20.1	General.....	61
20.20.2	Purpose	61
20.20.3	Procedure	62
20.20.4	Requirements	62
20.21	Sharp edge test.....	62
20.21.1	General.....	62
20.21.2	Purpose	62
20.21.3	Procedure	62
20.21.4	Requirement	63

20.22 Blocked heat sink test	63
20.22.1 Purpose	63
20.22.2 Procedure	63
20.22.3 Requirement	63
20.23 Locked rotor test	63
20.23.1 Purpose	63
20.23.2 Procedure	63
20.23.3 Requirement	64
Annex	65
Annex. A Bimetallic junction (Informative)	65
Annex. B Recommendations for testing of modules from production (Normative)	66
B. 1 General	66
B. 2 Module output power	66
B. 3 Insulation test	66
B. 4 Wet insulation test	66
B. 5 Visual inspection	67
B. 6 Cable connections	67
B. 7 Bypass diodes	67
B. 8 Ground continuity	67
Annex C Alternative test method to electricity safety of CPV receivers. (Normative)	68
C.1 Scope and object.....	68
C.2 Normative references	68
C.3 Specifications for the proposed test method	68
C.4 Test Method	69
C.5 Test procedure	69
C.6 Bibliography	73
Figure 1 – Schematic of a point-focus dish PV concentrator	17
Figure 2 – Schematic of a linear focus trough PV concentrator.....	17
Figure 3 – Schematic of a point-focus Fresnel lens PV concentrator	18
Figure 4 – Schematic of a linear-focus Fresnel lens PV concentrator	20
Figure 5 – Field connection warning label	21
Figure 6 – Symbol for hot surface can be used.....	21
Figure 7 – IEC 62688 safety test plan for CPV modules	46
Figure 8 – Combined IEC 62108 and IEC 62688 test plan for CPV modules	48
Figure 9 - IEC 62688 safety test plan for CPV assemblies.....	48
Figure 10 – Combined IEC 62108 and IEC 62688 test plan for CPV assemblies.....	49
Figure 11 – Waveform of the impulse voltage test	58
Figure A.1 – Voltages developed on bimetallic junction – from IEC 60943	65
Figure C.1 – Decision chart of the alternative test	69
Figure C.2 –. Equation (1).....	70
Figure C.3 – Example of the acceleration of the breakdown voltage degradation by the voltage stress.	70
Table C.1 – Maximum acceptable testing time.....	72
Figure C.4 – Fitting to the power function in the double logarithmic chart.	72

Table 1 – Touch temperature limits	21
Table 2 – Sizes of terminals for supply conductors	32
Table 3 – Minimum acceptable clearance distances	36
Table 4 – Multiplication factors for clearances of equipment rated for operation at altitudes up to 5 000 m	37
Table 5 – Minimum creepage distances for basic insulation	37
Table 6 – Minimum creepage distances for reinforced insulation	37
Table 7 – Rated impulse voltage	38
Table 8 – Wall thickness of polymeric boxes intended for conduit	41
Table 9 – Preconditioning tests	42
Table 10 – General inspection tests	42
Table 11 – Electrical shock hazard tests	43
Table 14 – Mechanical stress tests	43
Table 15 – Impulse voltage versus maximum system voltage	58

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**CONCENTRATOR PHOTOVOLTAIC (CPV)
MODULE AND ASSEMBLY SAFETY QUALIFICATION**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62688 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
82/XX/FDIS	82/XX/RVD

Full information on the voting for the approval of this International Standard 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 document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,

- replaced by a revised edition, or
- amended.

The National Committees are requested to note that for this document the stability date is 2021

THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE DELETED AT THE PUBLICATION STAGE.

CONCENTRATOR PHOTOVOLTAIC (CPV) MODULE AND ASSEMBLY SAFETY QUALIFICATION

1 Scope

This document describes the fundamental construction and testing requirements for Concentrator Photovoltaic (CPV) modules and assemblies in order to provide safe electrical and mechanical operation during their expected lifetime. Specific topics are provided to assess the prevention of electrical shock, and personal injury due to mechanical and environmental stresses.

This document attempts to define the basic requirements for various application classes of concentrator photovoltaic modules and assemblies, but it cannot be considered to encompass all national and regional codes.

This document is designed so that its test sequence can coordinate with those of IEC 62108, so that a single set of samples may be used to perform both the safety and performance evaluation of a CPV module and assembly.

CPV modules that are constructed in the flat plate module format and operate at 3X and less geometric concentration ratio are considered for evaluation to IEC 61730 *Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction, and Part 2: Requirements for testing*.

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 60050 -511:2018, *International Electrotechnical Vocabulary (IEV) - Part 511: Nano-enabled electrotechnical products and systems*

IEC 60060-1, *High-voltage test techniques - Part 1: General definitions and test requirements*

IEC 60112:2003+AMD1:2009 CSV, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*
IEC 60216-5:2008, *Electrical insulating materials - Thermal endurance properties - Part 5: Determination of relative thermal endurance index (RTE) of an insulating material*
IEC 60243-2:2013, *Electric strength of insulating materials - Test methods - Part 2: Additional requirements for tests using direct voltage*

IEC 60417:2002 DB, *Graphical symbols for use on equipment - 12-month subscription to regularly updated online database comprising all graphical symbols published in IEC 60417*

IEC 60529:1989/AMD2:2013/COR1:2019 , *Corrigendum 1 - Amendment 2 - Degrees of protection provided by enclosures (IP Code)*

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests*
IEC 60664-3:2016, *Insulation coordination for equipment within low-voltage systems - Part 3: Use of coating, potting or moulding for protection against pollution*

IEC 60664-1 -1:2020, *Insulation coordination for equipment within low-voltage supply systems - Part 1: Principles, requirements and tests*

- 41 IEC 60904-3:2019 RLV, *Photovoltaic devices - Part 3: Measurement principles for terrestrial*
42 *photovoltaic (PV) solar devices with reference spectral irradiance data*
- 43 IEC 60947-1:2007+AMD1:2010+AMD2:2014 CSV, *Low-voltage switchgear and controlgear - Part 1:*
44 *General rules* IEC 60950-1:2005+AMD1:2009+AMD2:2013 CSV, *Information technology equipment –*
45 *Safety – Part 1: General requirements*
- 46 IEC 61032:1997, *Protection of persons and equipment by enclosures - Probes for verification*
- 47 IEC 61140:2016, *Protection against electric shock – Common aspects for installation and equipment*
- 48 IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related*
49 *systems*
- 50 IEC 61730-1:2016, *Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction*
- 51 IEC 61730-2:2016, *Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing*
- 52 IEC TS 61836 :2016, *Solar photovoltaic energy systems - Terms, definitions and symbols*
- 53 IEC 62108:2019, *Concentrator photovoltaic (CPV) modules and assemblies – Design qualification and*
54 *type approval*
- 55 IEC 62670-1:2013, *Concentrator photovoltaic (CPV) performance testing – Part 1: Standard conditions*
- 56 IEC 62305-2:2010, *Protection against lightning - Part 2: Risk management*
- 57 IEC 62305-3:2010, *Protection against lightning - Part 3: Physical damage to structures and life hazard*
- 58 IEC 62548:2016, *Photovoltaic (PV) arrays - Design requirements*
- 59 IEC 62368-1, *Audio/video, information and communication technology equipment - Part 1: Safety*
60 *requirements*
- 61 IEC 62790:2020, *Junction boxes for photovoltaic modules - Safety requirements and tests*
- 62 IEC 62852:2014/AMD1:2020, *Amendment 1 - Connectors for DC-application in photovoltaic systems -*
63 *Safety requirements and tests*
- 64 ISO 179-1, *Plastics -- Determination of Charpy impact properties -- Part 1: Non-instrumented impact*
65 *test*
- 66 ISO 261, *ISO general-purpose metric screw threads – General plan*
- 67 ISO 262, *ISO general-purpose metric screw threads – Selected sizes for screws, bolts and nuts. Media*
68 *and price*
- 69 ISO 527-1, *Plastics -- Determination of tensile properties -- Part 1: General principles*
- 70 ISO 1456, *Metallic and other inorganic coatings – Electrodeposited coatings of nickel, nickel plus*
71 *chromium, copper plus nickel and of copper plus nickel plus chromium*
- 72 ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles -- Specifications and test*
73 *methods*
- 74 ISO 2081, *Metallic coatings – Electroplated coatings of zinc on iron or steel*

- 75 ISO 2093, *Electroplated coatings of tin - Specification and test methods*
- 76 ISO 4892-2, *Plastics – Methods of Exposure to Laboratory Light Sources – Part 2: Xenon Arc Lamps*
- 77 ENV 1187-1 to -4, *Test methods for roof coverings under the influence of a thermal attack of burning*
78 *brands and radiant heat*
- 79 ANSI/UL 746B, *Standard for Polymeric Materials - Long Term Property Evaluations*
- 80 UL 746C, *Standard for Polymeric Materials - Use in Electrical Equipment Evaluations*
- 81 UL 1703, *Standard for Flat-Plate Photovoltaic Modules and Panels*
- 82 ASTM E162-13, *Standard Test Method for Surface Flammability of Materials Using a Radiant Heat*
83 *Energy Source*
- 84 IEC62790, *Junction boxes for photovoltaic modules - Safety requirements and tests*
- 85

86 **3 Terms and definitions**

87 For the purposes of this document, the terms and definitions given in IEC 60050, IEC 60664-1, IEC TS
88 60904-1-2, IEC 61140, IEC TS 61836 and the following apply.

89 ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- 90 · IEC Electropedia: available at <http://www.electropedia.org/>
- 91 · ISO Online browsing platform: available at <http://www.iso.org/obp>

92 See Figure 1 to Figure 4 as schematics of various types of CPV.

93 **3.1**

94 **concentrator**

95 term associated with photovoltaic devices that use concentrated sunlight

96 **3.2**

97 **concentrator cell**

98 basic photovoltaic device that is used under the illumination of concentrated sunlight

99 **3.3**

100 **concentrator optics**

101 optical device that performs one or more of the following functions from its input to output: increasing
102 the light intensity, filtering the spectrum, modifying light intensity distribution or changing light direction

103 Typically, it is a lens or a mirror. A **primary optics** receives unconcentrated sunlight directly from the
104 sun. A **secondary optics** receives concentrated or modified sunlight from another optical device, such
105 as primary optics or another secondary optics.

106 **3.4**

107 **concentrator receiver**

108 group of one or more concentrator cells and secondary optics (if present) that accepts concentrated
109 sunlight and incorporates the means for thermal and electric energy transfer

110 A receiver could be made of several sub-receivers. The sub-receiver is a physically standalone, smaller
111 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**normal condition**

condition in which all means for protection against hazards are intact

3.8**single fault condition**

condition in which one means for protection against a hazard is defective or one fault is present which could cause a hazard

3.9**creepage distance**

shortest distance along the surface of the insulating material between two conductive parts

3.10**clearance**

shortest distance in air between two conductive parts

3.11**solid insulation**

solid insulating material interposed between two conductive parts

3.12**cemented joint**

insulating adhesive material that provides a reliable bond between two materials for which it has been evaluated to adhere

Two separate materials that have been cemented together with an insulating adhesive material can be considered as a solid insulating material.

3.13**comparative tracking index****CTI**

numerical value of the maximum voltage in volts which a material can withstand without tracking and without a persistent flame occurring under specified test conditions

3.14**transient overvoltage**

short-duration overvoltage of few milliseconds or less, oscillatory or non-oscillatory, usually highly damped

157 Transient overvoltages may be immediately followed by temporary overvoltages. In such cases the two
158 overvoltages are considered as separate events.

159 IEC 60071-1 defines three types of transient overvoltages, namely slow-front overvoltages, fast-front
160 overvoltages and very fast-front overvoltages according to their time to peak, tail or total duration, and
161 possible superimposed oscillations.

162 **3.15**

163 **partial discharge**

164 electric discharge that only partially bridges the insulation between conductors

165 A partial discharge may occur inside the insulation or adjacent to a conductor.

166 Scintillations of low energy on the surface of insulating materials are often described as partial
167 discharges but should rather be considered as disruptive discharges of low energy, since they are the
168 result of local dielectric breakdowns of high ionization density, or small arcs, according to the
169 conventions of physics.

170 **3.16**

171 **conformal coating <for printed wiring boards>**

172 electric insulating coating applied to loaded printed wiring boards to produce a thin layer conforming to
173 the surface to provide a protective barrier against deleterious environmental effects

174 **3.17**

175 **pollution**

176 any addition of foreign matter, solid, liquid or gaseous that can produce a permanent reduction of
177 dielectric strength or surface resistivity of the insulation.

178 Ionized gases of a temporary nature are not considered as to be a pollution.

179 **3.18**

180 **electrical hazard**

181 potential source of harm when electric energy is present in an electrical installation

182 Limited in this document to 75 V DC or greater.

183 **4 Sampling**

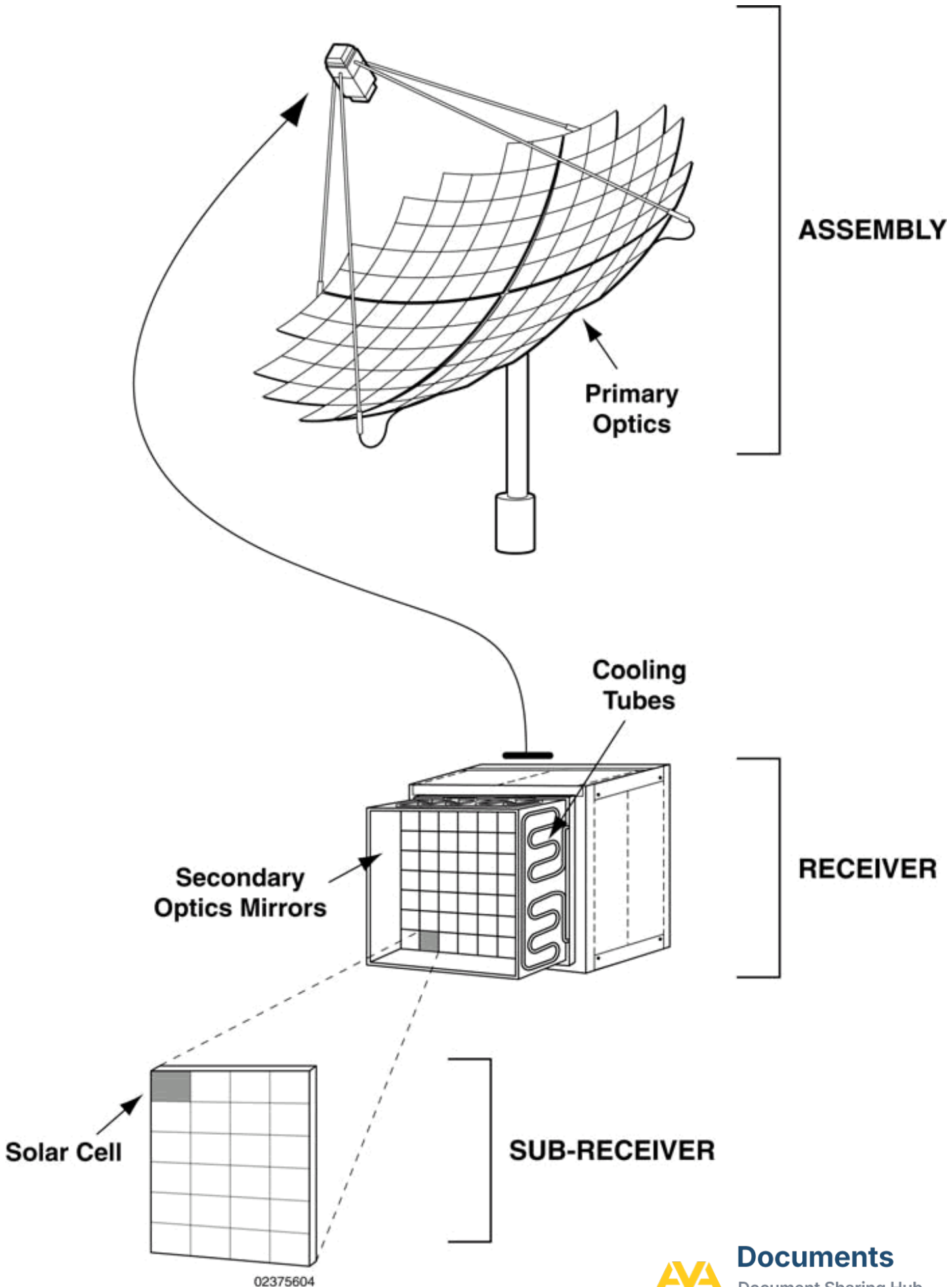
184 For non-field-adjustable focus-point CPV systems or modules, at least 6 standard production modules
185 are required to complete a full test protocol including all the specified tests, plus one special module,
186 prepared for the bypass/blocking diode thermal test (intrusive or non-intrusive) and CPV Temperature
187 test. For details, see Figures 7 and 8 and. Sample size has been optimized to reduce number of samples
188 in a combined program with IEC 62108.

189 For field-adjustable focus-point CPV systems or assemblies, at least 7 receivers (including secondary
190 optics sections, if applicable) and at least 9 primary optics – referred to hereafter as mirrors – are
191 required to complete all the specified tests, plus one special receiver for the bypass/blocking diode
192 thermal test (intrusive or non-intrusive).

193 For details, see Figures 9 and 10 and. Sample size has been optimized to reduce number of samples
194 in a combined program with IEC 62108.

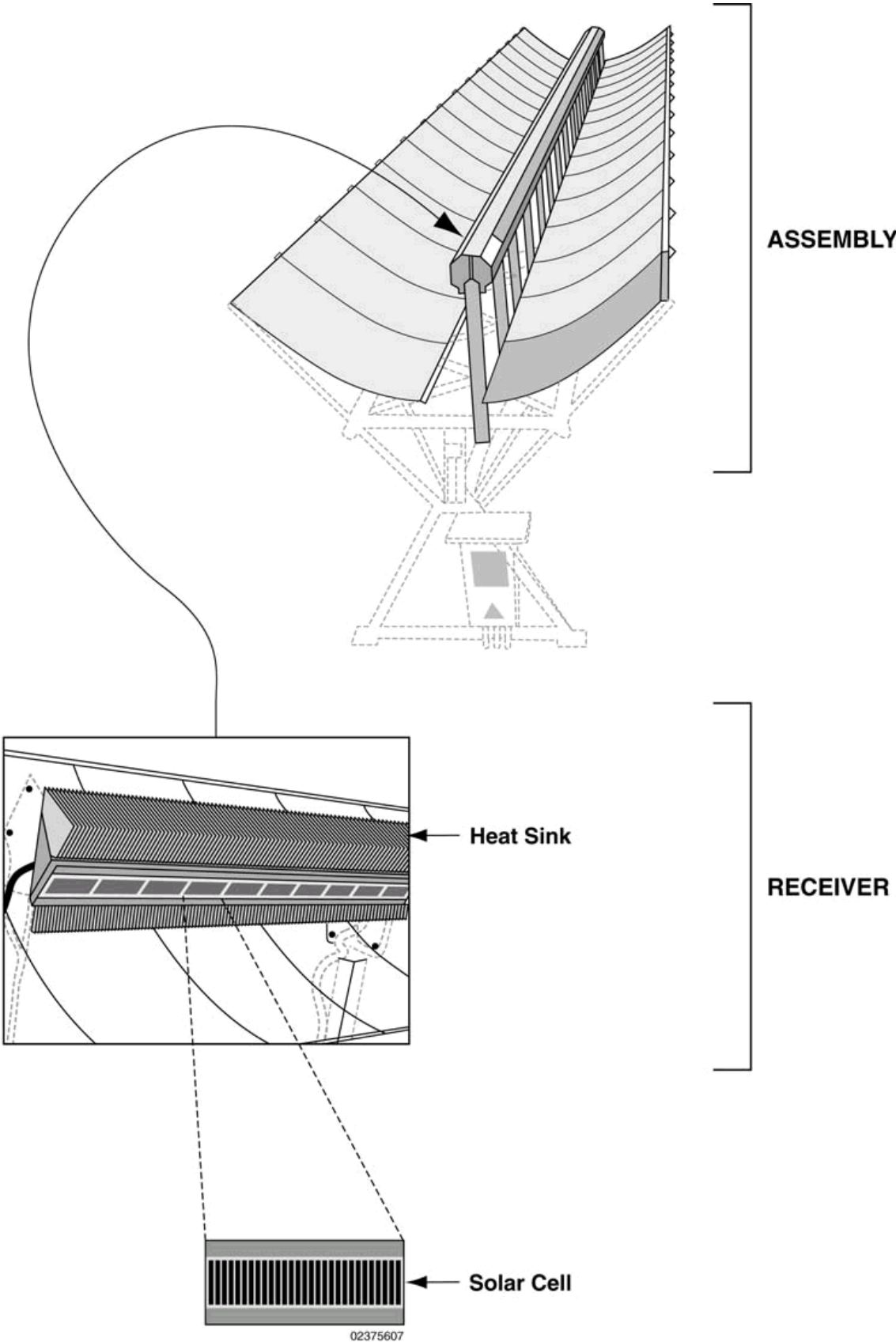
195 In the case that a full-size module or assembly is too large to fit into available testing equipment, such
196 as environmental chambers, or a full-size module or assembly is too expensive (*e.g., for a 20 kW*
197 *reflective dish concentrator system, 9 receiver samples account for 180 kW of PV cells*),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

- 201 Representative samples shall include all components, except some repeated parts. If possible, the
202 representative samples should use sub-receivers, sub-modules, or subassemblies. During the design
203 and manufacturing of the representative samples, much attention shall be paid to reach the maximum
204 similarity to the full-size component in all electrical, mechanical, and thermal characteristics related to
205 quality and reliability. Specifically, the cell string in representative samples should be long enough to
206 include at least two bypass diodes, but in no case less than ten cells. The encapsulations, interconnects,
207 terminations, and the clearance distances around all edges shall be the same as on the actual full-size
208 products. Other representative components, including lens/housing joints, receiver/housing joints, and
209 end plate/lens shall also be included and tested.
- 210 Test samples should be taken at random from a production batch or batches. When the samples to be
211 tested are prototypes of a new design and not from production, or representative samples are used,
212 these facts shall be noted in the test report (see Clause 6).
- 213 The test samples shall have been manufactured from specified materials and components in accordance
214 with the relevant drawings and process instructions and have been subjected to the manufacturer's
215 normal inspection, quality control, and production acceptance procedures. They shall be complete in
216 every detail and be accompanied by the manufacturer's handling, mounting, connection, and operation
217 manuals. Samples shall not be subjected to other special procedures that are not a part of standard
218 production.
- 219 If the intrusive bypass/blocking diode thermal test is to be performed, an additional specially
220 manufactured receiver or module is required with extra electrical and thermal detector leads so that
221 each individual diode can be accessed separately.



223

Figure 1 – Schematic of a point-focus dish PV concentrator



224

225

Figure 2 – Schematic of a linear focus trough PV concentrator

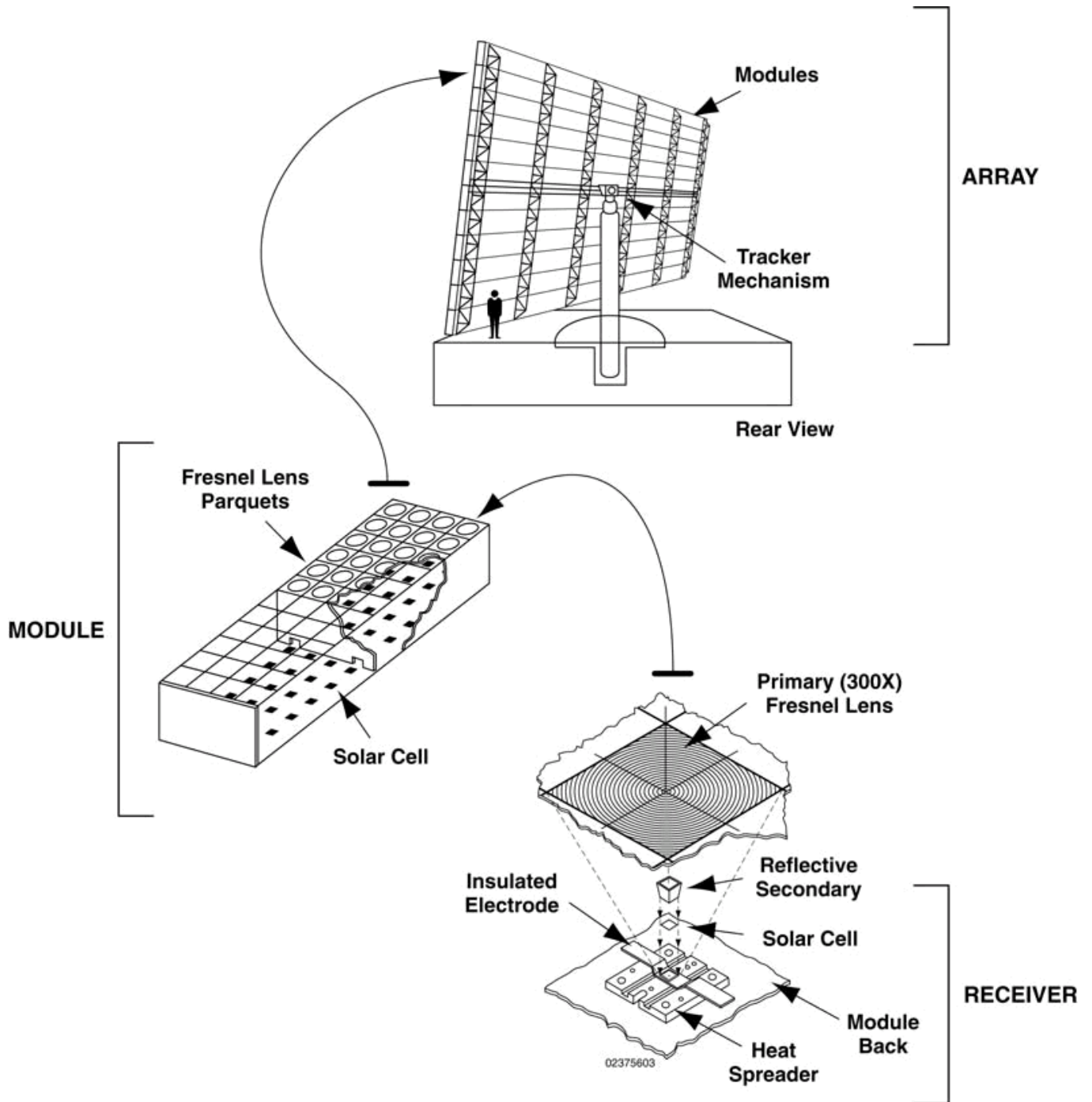


Figure 3 – Schematic of a point-focus Fresnel lens PV concentrator

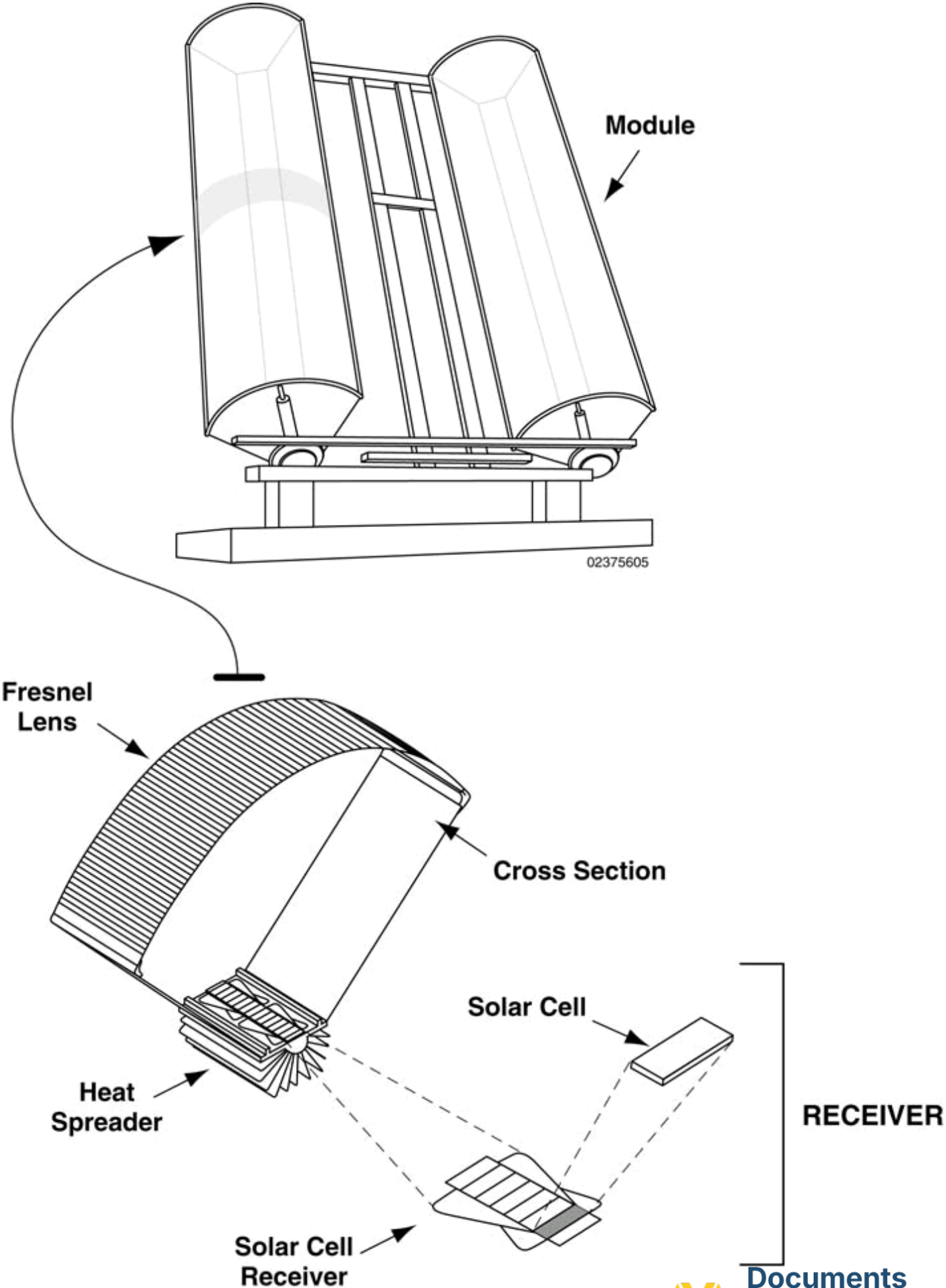


Figure 4 – Schematic of a linear-focus Fresnel lens PV concentrator

5 Marking

5.1 Nameplate

Each module or assembly shall carry the following clear and indelible markings:

- name, monogram or symbol of the manufacturer;
- type or model number;
- serial number;
- polarity of terminals or leads (colour coding is permissible);
- maximum system voltage;
- Application class of product.
- maximum over-current protection rating, as verified by the Reverse Current Overload test;
- nominal values of maximum output power at concentrator standard operating conditions (CSOC) as defined in IEC 62670-1 specified for the product type after preconditioning;
- rated voltage at open-circuit at CSOC;
- rated current at short-circuit at CSOC;
- β , the temperature coefficient of open circuit voltage.

The date and place of manufacture shall be marked on the module or be traceable from the serial number.

CSOC – (Concentrator Standard Operating Conditions)

- Irradiance: 900 W·m⁻² direct normal irradiance.
- Temperature: 20 °C local ambient temperature.
- Spectrum: Direct normal AM1.5 spectral irradiance distribution consistent with conditions described in IEC 60904-3.
- Wind speed: 2 m/s

5.2 Hazards

5.2.1 High intensity light

Where there is a possibility of eye hazard from high intensity reflected or direct beam light – based on proximity, a sign shall be located in an area near the system and be legibly marked with the following words, or equivalent:

“CAUTION: HIGH INTENSITY LIGHT – This product reflects or concentrates light at high concentration – Use appropriate eye protection when near”

If a unit allows access to concentrated irradiance above a maximum geometric ratio of 3X, there shall be marking located in the vicinity of the hazard, where readily visible, with the following words, or equivalent:

“CAUTION: HIGH INTENSITY LIGHT – To reduce the risk of burns – Keep Away”

5.2.2 Field connections

Connectors not rated for disconnection under load shall be marked (See Figure 5):

“CAUTION: Do not disconnect under load”



Figure 5 – Field connection warning label

[Image Ref: IEC 62852 (EN 50521), Connectors for photovoltaic systems. Safety requirements and tests]

5.2.3 Hot surfaces

A unit that exceeds the temperature limits specified in Table 1 shall be legibly marked, where readily visible after installation, with the words, or equivalent (See Figure 6):

“CAUTION: HOT SURFACES – To reduce the risk of burns – DO NOT TOUCH”

Accessible surfaces shall not exceed the values of the table below in NORMAL CONDITION, or 105 °C in SINGLE FAULT CONDITION, at an ambient temperature of 40 °C, or the maximum rated ambient temperature if higher.

If accessible heated surfaces are necessary for functional reasons, they are permitted to exceed the values of the table below in NORMAL CONDITION and to exceed 105 °C in SINGLE FAULT CONDITION, provided that they are recognizable as such by appearance or function or are marked with symbol below.

	IEC 60417 – 5041	Caution, hot surface
--	------------------	----------------------

Figure 6 – Symbol for hot surface can be used

Surfaces protected by guards that prevent them from being touched accidentally are not considered to be easily touched surfaces, provided that the guards cannot be removed without the use of a tool.

Table 1 – Touch temperature limits

Part		Limit °C
1	Outer surface ENCLOSURE	
	a) Metallic	70
	b) Non-metallic	80
	c) Small areas that are not likely to be touched in NORMAL USE	100

If a SINGLE FAULT CONDITION results unavoidably in another SINGLE FAULT CONDITION, the two failures are considered as one SINGLE FAULT CONDITION.

6 Report

Following completion of the procedure, a certified report of the tests shall be prepared by the test agency. Each certificate or test report shall include at least the following information.

a) A title;