

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Photovoltaic concentrators (CPV) – Performance testing –
Part 3: Performance measurements and power rating**

**Concentrateurs photovoltaïques (CPV) – Essai de performances –
Partie 3: Mesurages de performances et rapport de puissance**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2017 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

65 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Catalogue IEC - webstore.iec.ch/catalogue

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

Recherche de publications IEC - www.iec.ch/searchpub

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

65 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: csc@iec.ch.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Photovoltaic concentrators (CPV) – Performance testing –
Part 3: Performance measurements and power rating**

**Concentrateurs photovoltaïques (CPV) – Essai de performances –
Partie 3: Mesurages de performances et rapport de puissance**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 27.160

ISBN 978-2-8322-3859-2

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	5
1 Scope.....	7
2 Normative references	7
3 Concepts	7
4 Sampling	11
5 DUT marking and information	11
5.1 Indelible marking	11
5.2 Preliminary information indicated by manufacturer	11
6 Testing	11
7 Report	12
8 Standard apparatus requirements	13
8.1 Irradiance measurement equipment	13
8.1.1 Normal incidence pyrheliumeter (NIP).....	13
8.1.2 Global normal irradiance pyranometer	13
8.1.3 Spectral measurement device.....	13
8.1.4 Component reference cells	14
8.1.5 Indoor reference irradiance sensor	14
8.1.6 Auxiliary irradiance sensor.....	15
8.2 Solar simulator.....	15
8.2.1 General requirements	15
8.2.2 Continuous light simulator	15
8.2.3 Single-flash pulse simulator.....	16
8.2.4 Multi-flash pulse simulator	16
8.3 Solar tracker or DUT mounting system.....	16
8.3.1 General	16
8.3.2 Pointing error sensor	16
8.4 Temperature measurement and control.....	16
8.4.1 DUT temperature sensor.....	16
8.4.2 Ambient temperature sensor	16
8.4.3 Lens or optics temperature sensor	16
8.4.4 Temperature control system	17
8.5 Current-voltage measurement.....	17
8.6 Anemometer	17
8.7 Electrical load	17
9 Test procedures	18
9.1 Measurement of DUT temperature coefficients.....	18
9.1.1 Purpose.....	18
9.1.2 Apparatus.....	18
9.1.3 Data collection procedure and data requirements	18
9.1.4 Temperature coefficient determination.....	21
9.2 DUT reference V_{OC} at (900 W/m ² and 25 °C cell temperature).....	22
9.2.1 General	22
9.2.2 Reference V_{OC} dark I-V procedure	22
9.2.3 Reference V_{OC} using a solar simulator	23
9.3 Calculating the average DUT cell temperature	23
9.3.1 Purpose.....	23

9.3.2	Procedure.....	24
9.4	Reference irradiance sensor calibration and reference I_{SC} determination	24
9.4.1	Purpose.....	24
9.4.2	Data requirements	24
9.4.3	Determination of the calibrated and reference I_{SC} , ($I_{SC, cal}$ and I_{SCR}).....	24
9.4.4	Calibration requirement	26
9.5	Indoor I-V measurements of a CPV DUT	26
9.5.1	Purpose.....	26
9.5.2	General measurement requirements	26
9.5.3	DUT indoor alignment procedure	28
9.5.4	Procedure for single-flash pulsed solar simulators	28
9.5.5	Procedure for multi-flash pulsed solar simulators.....	28
9.6	Outdoor I-V measurements of a CPV DUT	28
9.6.1	Purpose.....	28
9.6.2	Apparatus.....	28
9.6.3	Procedure.....	29
9.6.4	Report	29
9.7	CSOC and CSTC power ratings	30
9.7.1	Data filtering requirements for CSOC or CSTC translation	30
9.7.2	CSOC power determination	31
9.7.3	CSTC power determination.....	31
9.8	DUT alignment procedure and measurement of misalignment sensitivity.....	32
9.8.1	Purpose.....	32
9.8.2	Apparatus.....	32
9.8.3	Recommendations for initial DUT mounting	33
9.8.4	General requirements	33
9.8.5	Individual off-axis sweeps and final DUT alignment	33
9.8.6	Alternate ellipse plot procedure for reporting misalignment sensitivity.....	34
9.8.7	Reporting.....	34
9.9	Mounting and aligning the pointing error sensor and other alignment sensitive equipment	35
9.9.1	Purpose.....	35
9.9.2	Procedure.....	35
9.10	Outdoor lens temperature performance test	35
9.10.1	General guidance	35
9.10.2	Procedure.....	36
9.10.3	Reporting.....	37
9.11	Indoor lens temperature performance test.....	38
9.11.1	General guidance	38
9.11.2	Procedure.....	38
9.11.3	Reporting.....	39
	Bibliography.....	40
	Figure 1 – Collimating tube geometry.....	9
	Figure 2 – Solar tracker pointing error.....	10
	Figure 3 – Example of acceptance angle data for a CPV DUT	10
	Figure 4 – Flow chart of performance testing for the DUT	12
	Figure 5 – V_{OC} data after an uncover event.....	20

Figure 6 – Figure 5 repeated after removing one data point21

Figure 7 – The derivative of dark I-V data plotted to determine R_S 23

Figure 8 – Iterative approach to determine I_{SC} and V_{OC}26

Figure 9 – Raw data for extracting the impact of lens temperature37

Figure 10 – Filtered data for extracting impact of lens temperature37

Table 1 – SMR requirements for indoor measurements27

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**PHOTOVOLTAIC CONCENTRATORS (CPV) –
PERFORMANCE TESTING –**
Part 3: Performance measurements and power rating**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 62670-3 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
82/1204/FDIS	82/1233/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.

A list of all parts in the IEC 62670 series, published under the general title *Photovoltaic concentrators (CPV) – Performance testing*, can be found on the IEC website.

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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

PHOTOVOLTAIC CONCENTRATORS (CPV) – PERFORMANCE TESTING –

Part 3: Performance measurements and power rating

1 Scope

This part of IEC 62670 defines measurement procedures and instrumentation for determining concentrator photovoltaic performance at concentrator standard operating conditions (CSOC) and concentrator standard test conditions (CSTC), defined in IEC 62670-1, including power ratings.

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

IEC 60904-2, *Photovoltaic devices – Part 2: Requirements for photovoltaic reference devices*

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

IEC 60904-4:2009, *Photovoltaic devices – Part 4: Reference solar devices – Procedures for establishing calibration traceability*

IEC 60904-10, *Photovoltaic devices – Part 10 Methods of linearity measurement*

IEC 62670-1, *Photovoltaic concentrators (CPV) – Performance testing – Part 1: Standard conditions*

IEC 62817:2014, *Photovoltaic systems – Design qualification of solar trackers*

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

ISO 2859-1, *Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 9060:1990, *Solar energy – Specification and classification of instruments for measuring hemispherical solar and direct solar radiation*

3 Concepts

The following concepts are used through this document.