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Measurement protocols for photovoltaic devices based on organic, dye-sensitized or perovskite materials

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National foreword

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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MEASUREMENT PROTOCOLS FOR PHOTOVOLTAIC DEVICES BASED ON ORGANIC, DYE-SENSITIZED OR PEROVSKITE MATERIALS

FOREWORD

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The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 63228, which is a Technical Report, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this Technical Report is based on the following documents:

Enquiry draft	Report on voting
82/1502/DTR	82/1555A/RVDTR

Full information on the voting for the approval of this technical report 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- withdrawn,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.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

For years, considerable research effort worldwide has been invested in the development of new thin-film photovoltaic (PV) technologies that may offer lower cost production, new applications or both. In particular, organic photovoltaics (OPV), dye-sensitised solar cells (DSC) and perovskite solar cells (PSC) have generated great interest and the market potential of these products is being explored.

To date, the performance of all new PV technologies has typically been determined using the test methods described in the IEC 60904 series and IEC 60891. However, these three technologies in particular present some additional measurement challenges that are at present not dealt with in these documents.

This document provides an overview of current best practices for measuring the performance of PV devices subject to these challenges. It seeks to highlight where the existing standards fail to accommodate the requirements of these technologies, to identify what additional measures may be needed for accurate determination of the device efficiency, and how these measures might be standardised in the future.

It is recognised that this is a rapidly developing field and many items presented are subject to ongoing active research. Therefore, currently no concrete suggestions can be made to amend existing IEC standards with respect to these technologies. However, as the field matures, it is expected that procedures evolve and lead to agreement between experts, so that they can be introduced into international standards. Whether this will consist of amending existing standards or in the issue of a separate standard collecting all procedures relevant to these technologies will be decided in the future.

MEASUREMENT PROTOCOLS FOR PHOTOVOLTAIC DEVICES BASED ON ORGANIC, DYE-SENSITIZED OR PEROVSKITE MATERIALS

1 Scope

This Technical Report summarises present perspectives on the performance evaluation of emerging PV technologies, specifically OPV, DSC and PSC devices. These devices present some challenges for accurate measurement under the existing IEC 60904 series of standards, which were developed in the context of silicon wafer solar cells. These challenges can be different for different devices, but in general they arise due to one or more of the following: instability in performance over time; unusual spectral responsivity; small device size; difficulty in measuring temperature; a transient response to external stimulus; optical interference effects; and a non-linear current response to irradiance. These challenges can lead to the cell output in laboratory testing being significantly different to the output that would be observed in a real application.

The primary focus of the report is measurement of the current-voltage (I-V) relationship under illumination for the purpose of determining the device output power, or power conversion efficiency. Where appropriate, the report makes reference to the IEC 60904 series which describes the standard approach to measuring the performance of all PV devices. The report also references existing published standards that seek to accommodate OPV, DSC or PSC devices.

The report does not seek to find consensus on measurement protocols at this stage. A lot of work has been done by the community toward that aim, but more work is needed. The report therefore seeks to document current knowledge and practices, hence serving as a reference and a tool for conducting further discussion. It is hoped that by identifying the issues that remain unresolved, the report will focus efforts toward resolving those issues, such that a guiding Technical Specification can be prepared in the near future. A robust Technical Specification will bring clarity and confidence to the markets for these PV products as they develop.

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 TS 61836, *Solar photovoltaic energy systems – Terms, definitions and symbols*

3 Terms, definitions and conventions

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61836 apply.

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp