

INTERNATIONAL STANDARD

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**Photovoltaic devices –
Part 1: Measurement of photovoltaic current-voltage characteristics**

**Dispositifs photovoltaïques –
Partie 1: Mesurage des caractéristiques courant-tension des dispositifs
photovoltaïques**



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PHOTOVOLTAIC DEVICES –

Part 1: Measurement of photovoltaic current-voltage characteristics

FOREWORD

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International Standard IEC 60904-1 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

This third edition cancels and replaces the second edition published in 2006. This edition constitutes a technical revision.

The main changes with respect to the previous edition are as follows:

- Updated scope to include all conditions.
- Added terms and definitions.
- Reorganised document to avoid unnecessary duplication.
- Added data analysis clause.
- Added informative annexes (area measurement, PV devices with capacitance, dark $I-V$ curves and effect of spatial non-uniformity of irradiance).

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

FDIS	Report on voting
82/1760/FDIS	82/1786/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 of IEC 60904 series, under the general title *Photovoltaic devices*, 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

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PHOTOVOLTAIC DEVICES –

Part 1: Measurement of photovoltaic current-voltage characteristics

1 Scope

This part of IEC 60904 describes procedures for the measurement of current-voltage characteristics (I - V curves) of photovoltaic (PV) devices in natural or simulated sunlight. These procedures are applicable to a single PV solar cell, a sub-assembly of PV solar cells, or a PV module. They are applicable to single-junction mono-facial PV devices. For other device types, reference is made to the respective documents, in particular for multi-junction devices to IEC 60904-1-1 and for bifacial devices to IEC TS 60904-1-2. Additionally informative annexes are provided concerning area measurement of PV devices (Annex A), PV devices with capacitance (Annex B), measurement of dark current-voltage characteristics (dark I - V curves) (Annex C) and effects of spatial non-uniformity of irradiance (Annex D).

NOTE The methods provided in this document can also be used as guidance for taking I - V curves of PV arrays. For on-site measurement refer to IEC 61829.

This document is applicable to non-concentrating PV devices for use in terrestrial environments, with reference to (usually but not exclusively) the global reference spectral irradiance AM1.5 defined in IEC 60904-3. It may also be applicable to PV devices for use under concentrated irradiation if the application uses direct sunlight and reference is instead made to the direct reference spectral irradiance AM1.5d in IEC 60904-3.

The purposes of this document are to lay down basic requirements for the measurement of I - V curves of PV devices, to define procedures for different measuring techniques in use and to show practices for minimising measurement uncertainty. It is applicable to the measurement of I - V curves in general. I - V measurements can have various purposes, such as calibration (i.e. traceable measurement with stated uncertainty, usually performed at standard test conditions) of a PV device under test against a reference device, performance measurement under various conditions (e.g. for device temperature and irradiance) such as those required by IEC 60891 (for determination of temperature coefficients or internal series resistance), by IEC 61853-1 (power rating of PV devices), or by IEC 60904-10 (for determination of output's linear dependence and linearity with respect to a particular test parameter). I - V measurements are also important in industrial environments such as PV module production facilities, and for testing in the field. Further guidance on I - V measurements in production facilities is provided in IEC TR 60904-14.

The actual requirements (e.g. for the class of solar simulator) depend on the end-use. Other standards referring to IEC 60904-1 can stipulate specific requirements. Where those requirements are in conflict with this document, the specific requirements take precedence.

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 reference devices*