

INTERNATIONAL STANDARD

IEC
904-9

First edition
1995-09

Photovoltaic devices –

Part 9: Solar simulator performance requirements

Dispositifs photovoltaïques –

Partie 9: Exigences pour le fonctionnement des simulateurs solaires



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* See web site address on title page.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PHOTOVOLTAIC DEVICES –

Part 9: Solar simulator performance requirements

FOREWORD

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International Standard IEC 904-9 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

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

DIS	Report on voting
82(CO)15	82(CO)22

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

PHOTOVOLTAIC DEVICES –

Part 9: Solar simulator performance requirements

1 Scope

This part of IEC 904 gives requirements for solar simulators used for indoor testing of terrestrial flat plate (non-concentrating) photovoltaic devices in conjunction with a spectrally matched reference device. The output of a solar cell is a strong function of the wavelength of the incident spectral irradiance distribution. To reduce measurement errors, this standard specifies the acceptable match to the reference spectral irradiance distribution, but it should be noted that the magnitude of the error is also affected by the spectral response mismatch between the reference device and the test specimen.

This part of IEC 904 covers both pulsed and steady-state simulators.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this part of IEC 904. At the time of publication, the edition indicated was valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 904 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 904-3: 1989, *Photovoltaic devices – Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data*

3 Type of simulators

Two types of solar simulators are commercially available for photovoltaic performance testing. The "steady-state" type (for example, filtered xenon, dichroic filtered tungsten - ELH or modified mercury vapour with tungsten electrodes) is suitable for single cells and small modules. The pulsed type, consisting of one or two long-arc xenon flash lamps, is better for large modules as it can irradiate large areas uniformly. Another advantage of this type is that there is negligible heat input to the test cells, so that they remain uniformly at the ambient temperature which can be easily and accurately measured. The pulse-forming network and the data acquisition and processing equipment are generally supplied as part of the simulator.

4 Simulator requirements

4.1 Total irradiance

The simulator shall be capable of producing the standard irradiance of $1000 \text{ W} \cdot \text{m}^{-2}$ (as measured with a reference device) at the test plane, and higher or lower irradiance levels as may be required.

4.2 Spectral match

The spectral irradiance distribution of the simulator shall match the reference spectral irradiance distribution to the extent indicated for the relevant class of simulator in table 1.

4.3 Uniformity

The irradiance in the test plane over the full extent of the designated test area, as measured with a suitable detector(s), shall be uniform to the degree specified for the relevant class of simulator in table 1.

For single cell and sub-assembly testing, the largest dimension of the detector shall be less than one-half of the smallest dimension of the cell.

In the case of a module, the detector shall be no bigger than a single component cell.

$$\text{Non-uniformity} = \pm \left[\frac{\text{maximum irradiance} - \text{minimum irradiance}}{\text{maximum irradiance} + \text{minimum irradiance}} \right] \times 100$$

where the maximum and minimum irradiance is that measured with the detector(s) over the designated test area (corrected for temporal instability).

4.4 Temporal stability

During the time of data acquisition, the irradiance shall be stable to the degree specified for the relevant class of simulator in table 1.

$$\text{Temporal instability (\%)} = \pm \left[\frac{\text{maximum irradiance} - \text{minimum irradiance}}{\text{maximum irradiance} + \text{minimum irradiance}} \right] \times 100$$

where the maximum and minimum irradiance is that measured with the detector at any particular point on the test plane during the time of data acquisition.

NOTE – For the special case of pulsed simulators, the temporal stability requirements apply only to the irradiance levels present during the actual measurement of each data point.

4.5 Characteristics check

The characteristics described in 4.1 to 4.4 shall be checked whenever there is any change in class A or B simulators (including aging) which could affect these characteristics beyond acceptable limits. The detectors used shall have an angle of view sufficient to accept all the incident light at any point on the test plane.

5 Data sheet

The following information shall be recorded on a data sheet that shall accompany each simulator:

- date of issue of data sheet;
- date of measurement;
- manufacturer;
- type;
- class (determined by the lowest classification of an individual characteristic);

- location of test plane;
- nominal test area;
- nominal lamp current;
- nominal irradiance;
- spectral irradiance distribution;
- non-uniformity of irradiance over the nominated area;
- maximum angle subtended by the light source (including reflected light) at any point on the test plane;
- temporal instability;
- for pulsed simulators, the characteristics of the pulse;
- for pulsed simulators, the time intervals between data points.

Table 1 – Simulator classification

Characteristic	Class A	Class B	Class C
Spectral match (ratio of the actual percentage of total irradiance to the required percentage specified in table 2 for each wavelength interval)	0,75 - 1,25	0,6 - 1,4	0,4 - 2,0
Non-uniformity of irradiance	$\leq \pm 2 \%$	$\leq \pm 5 \%$	$\leq \pm 10 \%$
Temporal instability	$\leq \pm 2 \%$	$\leq \pm 5 \%$	$\leq \pm 10 \%$

Table 2 – Reference spectral irradiance distribution*

Wavelength (λ) interval, μm	Percentage of total irradiance between 0,4 and 1,1 μm
0,4 to 0,5	18,5
0,5 to 0,6	20,1
0,6 to 0,7	18,3
0,7 to 0,8	14,8
0,8 to 0,9	12,2
0,9 to 1,1	16,1

* In accordance with the global reference solar spectral irradiance distribution given in IEC 904-3.