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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 11010-2025

Spectrum reference photovoltaic cells

光谱标准光伏电池

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1 Scope

GB/T 11010-2025 is the Chinese national standard on spectrum reference photovoltaic cells, in the field of energy and heat transfer engineering. The /T suffix marks it as a recommended standard: it is not compulsory by itself, but it becomes binding as soon as a contract, a tender or a customer specification calls it up - which in practice is how most foreign buyers meet it. It was issued on 31 December 2025 by the State Administration for Market Regulation; Standardization Administration of China, and has been in force since 1 July 2026. Classification: ICS 27.160, CCS K83. This page is published from the official record of the standard held by the Chinese standards administration: the identification, the dates, the classification and the issuing body are taken from there. The clause text, the tables and the numeric limits are in the document itself, which is delivered complete in English translation.

This document specifies the classification, requirements, and calibration of spectral reference photovoltaic cells. This document applies to reference photovoltaic cells used for calibrating monochromatic spectral irradiance when measuring the spectral response of photovoltaic cells, and also to reference photovoltaic cells used for calibrating the short-circuit current value generated by photovoltaic cells under various light sources with known spectral irradiance.

2 Normative references

The provisions of the following documents constitute the essential clauses of this document through normative references in this text. Among them, for any dated reference, only the version corresponding to that date applies to this document; for any undated reference, the latest version (including all amendments) applies to this document.

GB/T 2297 Terminology of solar photovoltaic energy system

GB/T 6495.1 Photovoltaic devices - Part

3 Terms and definitions

The terms and definitions defined in GB/T 2297, as well as the following terms and definitions, apply to this document.

3.1 primary spectrum reference photovoltaic cell Photovoltaic cells calibrated using standard detectors traceable to units of the International System of Units (SI).

3.2 secondary spectrum reference photovoltaic cell Photovoltaic cells calibrated against the primary spectrum reference photovoltaic cell.

4 Requirements

4.1 Technical requirements The technical requirements for spectral reference photovoltaic cells are as follows:

a) The spectral reference photovoltaic cell shall be a stable device, and its short-circuit current value shall not change by more than $\pm 1\%$ during the calibration period.

b) The fill factor of the I-V curve of the spectral reference photovoltaic cell under standard conditions should meet the following requirements. when the band gap of the PN junction material of the cell is less than

0.9 eV, the fill factor FF should be greater than 60%; when the band gap of the PN junction material of the cell is not less than

0.9 eV, the fill factor FF should be greater than 70%.

c) The nonlinearity of the short-circuit current and irradiance of the spectral reference photovoltaic cell shall be within $\pm 0.5\%$.

4.2 Packaging requirements Spectral reference photovoltaic cells should be packaged.

Figure A.1 in Appendix A is a schematic diagram of a typical spectral reference photovoltaic cell packaging.

5 Test methods

5.1 Electrical performance measurement Electrical performance measurements shall be performed in accordance with GB/T 6495.1.

5.2 Short-circuit current-irradiance nonlinear measurement The short-circuit current-irradiance nonlinear measurement shall be performed in accordance with GB/T 6495.10.

6 Calibration

6.1 Environment Calibration measurements shall be performed in a light-shielded laboratory at $(25 \pm 1) ^\circ\text{C}$.

6.2.1 Relative spectral response

6.2.1.1 Measuring equipment The measuring equipment shall meet the following requirements.

a) Standard detectors. Photodiodes or photovoltaic devices with calibrated relative spectral responsivity, etc. Multiple standard detectors shall be used in combination, if necessary, to cover the measurement wavelength range.

b) Light source. A steady-state light source shall be used, and the instability of the DC constant power supply shall be less than 0.1% within 10 minutes, and the current ripple coefficient shall be less than 1%. The spatial non-uniformity of monochromatic light in the test plane shall not exceed $\pm 2\%$.

c) Optical modulator. The modulation frequency is continuously adjustable, and the incident beam is modulated at a certain frequency when calibrating the relative spectral response; the modulation period shall be greater than the time constant of the battery under test; the modulation frequency instability shall be within 0.2% per hour.

d) Monochromator. The wavelength range shall cover the spectral response range of the spectral reference photovoltaic cell; the bandwidth shall not exceed 10 nm in the 280 nm~1200 nm range, and shall not exceed 15 nm in the 1200 nm~2500 nm range; the wavelength indication error shall meet the following requirements. not greater than

0.3 nm (in the 280 nm~1200 nm range) and not greater than 2 nm (in the 1200 nm~2500 nm range); stray radiation shall be less than 1×10^{-4} .

e) Lock-in amplifier system. The input impedance shall be no less than 10 M Ω ; the white noise suppression shall be no less than 120 dB; the amplification factor variation shall be less than 0.1% within the signal range.

f) Digital voltmeter. The accuracy shall not exceed $\pm 0.0025\%$.

g) Temperature controller. Temperature control accuracy shall be $\pm 0.5 ^\circ\text{C}$.

6.2.1.2 Measurement method A spectral response measurement device is used; the optical power of monochromatic light is calibrated with a standard detector. Then, the signal value of the spectral reference photovoltaic cell under test under monochromatic light is

measured under the same conditions. During both calibration and measurement, a monitoring detector is used to monitor the change in monochromatic light power. The relative spectral responsivity of the spectral reference photovoltaic cell under test is calculated using formula (1). where $S_{rel}(\lambda)$ -- the relative spectral responsivity of the spectral reference photovoltaic cell under test; $S_{strel}(\lambda)$ -- the relative spectral responsivity of a standard detector; $\Delta I_{mon,st}(\lambda)$ -- the optical power monitoring signal value when calibrated with a standard detector; $\Delta I_{mon,DUT}(\lambda)$ -- the optical power monitoring signal value when measuring the spectral reference photovoltaic cell under test; $\Delta I_{st}(\lambda)$ -- the signal value of the standard detector; $\Delta I_{DUT}(\lambda)$ -- the signal value of the spectral reference photovoltaic cell under test.

6.2.2 Absolute spectral response

6.2.2.1 Measuring equipment The measuring equipment shall meet the following requirements.

a) Monochromatic light source. Laser, light-emitting diode (LED) or monochromator light source, etc., with a bandwidth of no more than 10 nm in the range of 280 nm~1200 nm and no more than 15 nm in the range of 1200 nm~2500 nm; the wavelength indication error shall meet the following requirements. no more than

0.3 nm (in the range of 280 nm~1200 nm) and no more than 2 nm (in the range of 1200 nm~2500 nm), and the stability shall be better than 0.5% within 10 min.

b) Standard detector. such as a photodiode with known absolute spectral responsivity. Other measuring equipment shall meet the requirements of 6.2.1.1.

8 Measurement of spectral response of a photovoltaic (PV) device

GB/T6495.10 Photovoltaic devices - Part