



Standard Test Methods for Measuring Spectral Response of Photovoltaic Cells¹

This standard is issued under the fixed designation E 1021; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These test methods cover the determination of either the absolute or relative spectral response of a single, linear photovoltaic cell. These test methods require the use of a bias light.

1.2 These test methods are not intended for use with interconnected photovoltaic devices.

1.3 There is no similar or equivalent ISO standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method²

E 772 Terminology Relating to Solar Energy Conversion³

E 892 Tables for Terrestrial Solar Spectral Irradiance at Air Mass 1.5 for a 37° Tilted Surface²

E 927 Specification for Solar Simulation for Terrestrial Photovoltaic Testing³

E 973 Test Method for Determination of the Spectral Mismatch Parameter Between a Photovoltaic Device and a Photovoltaic Reference Cell³

E 1328 Terminology Relating to Photovoltaic Solar Energy Conversion³

3. Terminology

3.1 *Definitions*—Definitions of terms used in these test methods may be found in Terminology E 772 and in Terminology E 1328.

3.2 Symbols:

3.2.1 The following symbols and units are used in these test methods.

a —illuminated cell area, m^2 ,

A —irradiance normalization constant,

c —speed of light in vacuum, ms^{-1} ,

E —monochromatic source irradiance, Wm^{-2} ,

E_o —reference spectral irradiance, Wm^{-2} ,

h —Planck's constant, JHz^{-1} ,

I —current, A,

I_{sc} —solar cell short-circuit current, A,

K —relative-to-absolute spectral response conversion constant,

M —spectral mismatch parameter,

q —elementary charge, C,

Q —external quantum efficiency,

R_a —absolute spectral response, AW^{-1} ,

R_r —relative spectral response, and

λ —wavelength, nm or μm .

3.2.2 Symbolic quantities that are functions of wavelength appear as $X(\lambda)$.

4. Summary of Test Methods

4.1 The spectral response of the photovoltaic cell is determined by the following procedure:

4.1.1 A monochromatic, chopped beam of light is directed at normal incidence onto the cell. Simultaneously, a continuous white light beam (bias light) is used to illuminate the entire device at an irradiance approximately equal to normal end use operating conditions intended for the cell.

4.1.2 The spectral dependence of the ac (chopped) component of the short-circuit current is monitored as the wavelength of the incident light is varied over the response band of the cell. The total energy in the beam of chopped light as a function of wavelength is determined with an appropriate detector.

4.2 The absolute spectral response of a cell requires the knowledge of the absolute energy in the chopped beam. The detector must, therefore, be traceable to a National Institute of Standards and Technology (NIST) Detector Response Package,⁴ or other standards for blackbody detectors as appropriate. The absolute spectral response of the cell can then be computed using the measured cell response and the irradiance of the chopped source.

5. Significance and Use

5.1 The spectral response of a photovoltaic cell is required to interpret laboratory measurements on devices and is useful for theoretical calculations. The reference cell method of

¹ These test methods are under the jurisdiction of ASTM Committee E-44 on Solar, Geothermal, and Other Alternative Energy Sources and are the direct responsibility of Subcommittee E44.09 on Photovoltaic Electric Power Conversion. Current edition approved Oct. 10, 1995. Published January 1996.

² Annual Book of ASTM Standards, Vol 14.02.

³ Annual Book of ASTM Standards, Vol 12.02.

⁴ Zalewski, E. F., et al., "The NBS Detector Response Transfer and Intercomparison Package: Its Characteristics and Use," National Bureau of Standards, Radiometric Physics Division, Washington, D.C., 1980.