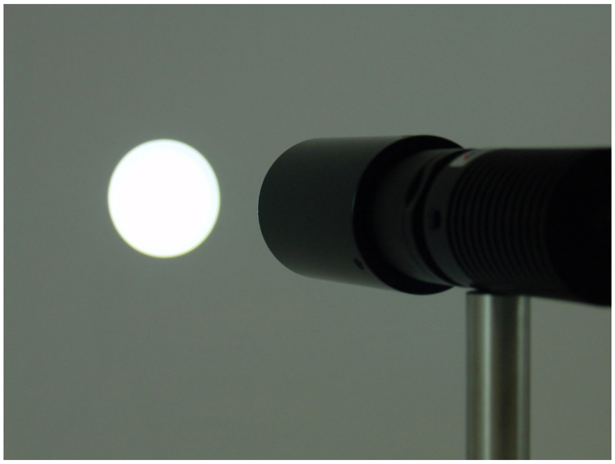
IAM Characterization System

Eos Research-Grade Indoor Incidence Angle Modifier (IAM) Characterization System

Datasheet



The Eos incidence angle modifier (IAM) characterization system is the research-grade solution for characterization of the relative angle-dependent response of any photovoltaic (PV) device. The system achieves unprecedented resolution of IAM characteristics with state-of-the-art optics and electronics. Eos' fully automated characterization process ensures high accuracy and repeatability as well as low process overhead.

The turn-key Eos system consists of an adjustable and highly collimated broadband "white" light source, a light source laser alignment system, a stepper-motor-controlled sample stage, high-resolution measurement electronics, and a supplied PC with software that enables fully automated characterizations. The Eos system is customized for each end-user's application, particularly with respect to PV device form-factor and available working distance. An important system parameter is the working distance between the light source and the sample stage, as light source collimation increases with working distance. Working distance is mainly limited by space constraints of the installation location. Measurement speed is a critical consideration with Eos, as measurement acquisition times can dramatically increase with angle-of-incidence (AOI). This is a consequence of larger AOI values corresponding to less measurement signal. Acquisition times are minimized at each AOI using an optimized low-noise measurement architecture and statistical signal-processing algorithms. These system features enable unmatched measurement resolutions.

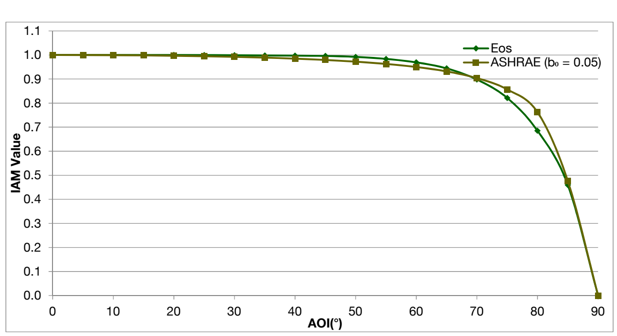
Key Applications

- Optical component evaluation
- Research and development
- Performance analysis
- Manufacturing process evaluation

Key Features

- Collimated and homogeneous broadband light source
- Laser alignment of normal incidence
- Low relative angle errors
- Light source position adjustable in test plane
- Fully automated characterization process

PV cells and modules are not created equally, especially regarding their finer performance parameters. Not only should cell short-circuit current at normal incidence [$I_{SC}(\theta=0)$] be maximized, the dependence of short-circuit current on angle-of-incidence [$I_{SC}(\theta)$] should follow the cosine law as closely as possible – perhaps even exceeding it with state-of-the-art optical designs. Careful optimization of $I_{SC}(\theta)$ is particularly important for building-integrated PV (BIPV) applications and other fixed-tilt deployments. $I_{SC}(\theta)$ can be optimized by careful choices of optical components, their interfaces, and the manufacturing process. Since the manufactured properties of each will affect $I_{SC}(\theta)$, high-resolution characterization of $I_{SC}(\theta)$ of manufactured photovoltaics will reveal system-level details that are otherwise difficult to uncover.



Eos IAM characterization data of a typical silicon PV module compared to the historically accepted ASHRAE model

Eos IAM Characterization System

Since the Eos system does not rely on any calibrated sensors for reference, measurement errors are dramatically reduced. Absolute measurement error is dominated by the error in referencing normal incidence. This error is minimized by means of a laser-alignment system. In contrast to outdoor IAM measurement techniques, the errors due to diffuse light on Eos measurements are eliminated. In fact, ambient light has no effect on the quality of measurement data obtained from Eos.

AOI (°)	Repeatability Error (%)	Total Expanded [k = 2] Measurement Uncertainty (%)
0	N/A	N/A
5	0.06	0.83
10	0.12	0.85
15	0.16	0.88
20	0.21	0.92
25	0.25	0.97
30	0.34	1.07
35	0.38	1.13
40	0.44	1.22
45	0.47	1.26
50	0.52	1.35
55	0.53	1.38
60	0.57	1.46
65	0.57	1.50
70	0.63	1.67
75	0.77	2.06
80	0.96	2.75
85	1.20	4.79
90	N/A	N/A

Eos raw measurement repeatability errors and expanded total measurement errors - the expanded total measurement error values are estimated according to the ISO/IEC Guide 98-3:2008 – Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)

It's important to note that when comparing PV modules with identical cell dimensions (e.g. standard six-inch polycrystalline PV cells), the relative measurement error (for example, when comparing the relative performances of test samples or products) is simply the repeatability error. Therefore, the accuracies of product comparisons made with Eos are unmatched by other IAM characterization techniques.

Specifications

Light-source Collimation	< 0.4° divergence (at working distance of 18.3 m)
Collimated Beam Diameter	Suitable for unmasked 15.6 cm silicon cells (or smaller), and suitable for larger cell dimensions when cell is appropriately masked
Relative Angle Error	< 0.02°
System Warranty	One year parts and labor on defects in materials or workmanship

Due to continuous product development, specifications are subject to change without notice.