



**FSEC Photovoltaic Module Characterization Facility (PVMCF)  
Testing Agreement**

**FSEC Fee Schedule**

**Discounts and Surcharges** **Percentage Discount/Surcharge of Total**  
*Discounts are calculated by taking the sum of the percentages and applying to the total.*

Measure a total of 10 or more modules	-15%
Bifacial modules (if both sides are being measured)	+75%

<b>PV Module Testing</b>	<b>Amount/Module</b>
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***Package Deals***

Standard Package	\$625 600
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- Reception and Processing
- *I-V* flash test (either Sinton FMT-350 or one-sun Spire 4600SLP)
- Standard EL imaging

Advanced Package	\$1300 1200
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- Reception and Processing
- *I-V* flash test (either Sinton FMT-350 or Spire 4600SLP at one intensity)
- *If I-V flash test on Spire 4600SLP at four intensities* +300\$
- EL sweep
- Dark *I-V* test
- UVF Imaging
- IR Thermography Imaging

Mechanical Loading IEC61215 Sequence (setup fee not included)	\$1300 1200
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- Additional setup fee (charged **one time**) \$500/module type
- 1000 cycles of  $\pm 1000$  Pa
- One cycle of 2400 Pa
- One cycle of 5400 Pa
- Sinton FMT-350 flash test and standard EL imaging performed for every:
  - 200 cycles of  $\pm 1000$  Pa
  - 400 Pa

Mechanical Loading IEC61215 Sequence – Expanded Measurements (setup fee not included)	\$1900 1700
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- Additional setup fee (charged **one time**) \$500/module type
- 1000 cycles of  $\pm 1000$  Pa
- One cycle of 2400 Pa
- One cycle of 5400 Pa
- Sinton FMT-350 flash test, dark *I-V*, and EL sweep imaging performed for every:

- 200 cycles of  $\pm 1000$  Pa
- 400 Pa

**Individual Measurements**

Reception and Processing ( <b>applied to all measurement agreements</b> )	\$25
Spire 4600SLP Flash Test	
Single Intensity (1 sun = 1000 W/m <sup>2</sup> )	\$300
Four intensities (0.25, 0.50, 0.75, and 1.00 suns)	\$600
Custom	Request quote
Sinton FMT-350 Flash Test	\$300
Suns- <i>V<sub>oc</sub></i> (for minimodules)	\$100
Dark <i>I-V</i> Test	\$150
EL Imaging	
Standard	\$300
EL Sweep	\$450
UVF Imaging	\$75
IR Thermography Imaging	\$300
High-Resolution non-contact EL, UVF, and PL scan	\$600
LoadSpot Mechanical Test	
Setup	\$500/module type
Test Time per Hour	\$200/hour
Flash testing at each loading Step	\$150
Standard EL Imaging at Each Loading Step	\$150
EL Sweep at Each Loading Step (Replaces Standard EL Imaging)	\$225
Dark <i>I-V</i> at Each Loading Step	\$75
IR Thermography Imaging at Each Loading Step	\$150

**Reporting and Analysis**

**Total Amount**

*Comprehensive Package Deals*

Standard Package ( <b>added by default unless otherwise stated by client</b> )	\$250
<ul style="list-style-type: none"> <li>• Summary table and boxplots of measured <i>I-V</i> parameters.</li> <li>• Summary of observations from EL images, visual images, and <i>I-V</i> data.</li> <li>• <i>I-V</i> curve data and plots.</li> <li>• <i>Sinton I-V</i>: p-<i>I-V</i> curves, and <i>I-V</i> overlaid with p-<i>I-V</i> curves.</li> <li>• Cropped EL images of each module.</li> <li>• <i>Bifacial testing also includes bifaciality calculations if both sides are measured.</i></li> <li>• <i>Mechanical load testing also includes plots of I-V parameters and GIFs of EL images with respect to loading conditions. E.g., I<sub>sc</sub> per 200 cycles of <math>\pm 1000</math> Pa.</i></li> </ul>	+\$250

## Advanced Package

\$1000

- *Everything in the Standard Package.*
- *I-V* performance loss rate analysis based on nameplate values as applicable.
- *I-V* parameters as a function of light intensity with plots.
- *Sinton I-V: I-V and p-I-V* data as a function of light intensity with plots.
- *Sinton I-V: effective lifetime versus carrier density* data and plots.
- EL sweep analysis with series resistance and recombination mapped for each cell in the module<sup>[1]</sup> (EL sweep imaging required).
- EL image analysis with series resistance and recombination resolved across the module area<sup>[2]</sup>.
- Cropped cells from module EL images.
- Machine learning defect detection of EL images<sup>[3]</sup>.
- Enhanced and cropped UVF images.
- Basic statistics from IR thermography images.
- Dark *I-V* curve analysis.
- *Bifacial testing also includes bifaciality calculations if both sides are measured.*
- *Mechanical load testing also includes these analyses as a function of loading conditions.*

+ \$1000

## Custom Package

Select analysis techniques from below and request quote.

### Sinton FMT-350

- Summary table and boxplots of measured *I-V* parameters.
- Plots of *I-V* curves, *p-I-V* curves, and *I-V* overlaid with *p-I-V* curves.
- *I-V and p-I-V* data as a function of light intensity with plots.
- *I-V* parameters as a function of light intensity with plots.
- Effective lifetime versus carrier density data with plots.
- *I-V* performance loss rate analysis based on nameplate values as applicable.
- *Mechanical load testing: I-V and p-I-V* performance and plots with respect to loading conditions.
- *Bifacial testing: any of the above comparing between both sides of each module, including bifaciality calculations.*

### Spire 4600SLP

- Summary table and boxplots of measured *I-V* parameters.
- Plots of *I-V* curves.
- *I-V* data as a function of light intensity with plots.
- *I-V* parameters as a function of light intensity with plots.
- *I-V* performance loss rate analysis based on nameplate values.
- *Bifacial testing: any of the above comparing between both sides of each module, including bifaciality calculations.*

### EL Imaging

- Summary of results.
- Module and cell cropping.
- GIFs of images.

- EL sweep analysis<sup>[1]</sup>: dark  $I$ - $V$  curves for each cell in the module. Performance characteristics obtained from these curves are mapped onto an image to visualize cell performance. *Contact us for details on half-cell or shingled cell modules.*
- EL pixel resolved analysis<sup>[2]</sup>: series resistance and recombination saturation current are mapped on a pixel-by-pixel map of the module to visualize performance across the module and cell surfaces. *Contact us for details on half-cell or shingled cell modules.*
- Machine learning defect detection<sup>[3]</sup>.
- *Mechanical load testing*: any of the above with respect to loading conditions.
- *Bifacial testing*: any of the above comparing between both sides of each module.

#### UVF Imaging

- Summary of results.
- Image enhancement and module cropping.

#### IR Thermography Imaging

- Summary of results.
- Basic statistics of module temperature.

#### Dark $I$ - $V$

- Curve analysis.