Aura Sol-X Smart

AAA CLASS SOLAR SIMULATOR IV SYSTEM

1. SYSTEM OVERVIEW

The **SOLAR TECH X-11** is a complete, multi-module photovoltaic characterization platform engineered specifically for cutting-edge laboratory research, advanced device validation, and material science applications. The system seamlessly integrates a maintenance-free, high-stability **Class AAA Solar Simulator** with a high-precision digital instrumentation core to execute accurate, repeatable, and fully automated multi-parameter testing.

By unifying hardware automation with real-time computational algorithms, the system eliminates traditional user setup errors and manual measurement drift. It supports high-fidelity characterization across all established and emerging thin-film or solid-state solar cell

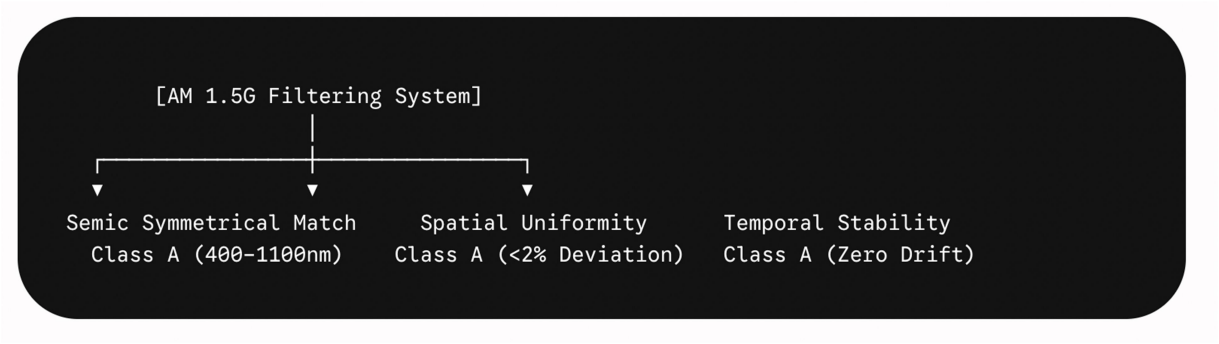
architectures, delivering key insights into operational efficiencies, lifecycle physics, and fundamental charge transport mechanisms.

Universal Photovoltaic Architecture Compatibility

- **Perovskite Solar Cells:** Designed to analyze specialized polarization dynamics, ion migration anomalies, and real-time transient shifts.
- **Organic Photovoltaics (OPV / OSC):** High-gain sensitivity channels allow precise resolution of lower current characteristics typical of advanced organic matrices.
- **Dye-Sensitized (DSSC) & Quantum Dot (QDSC) Cells:** Comprehensive tracking of multi-junction or nano-structured liquid/solid-state interfaces.
- **Conventional Silicon (Mono/Poly-Si) & Thin-Film Technologies:** Out-of-the-box support for rapid evaluation of traditional junctions, including CdTe and CIGS architectures.

2. OPTICAL ENGINE & ACCREDITED STANDARDS COMPLIANCE

The integrated optical assembly projects a continuous, uniform, and factory-stabilized light field engineered to replicate terrestrial solar distribution. The optical performance holds a verifiable certificate of compliance meeting the premium **Class AAA** matching rules dictated by international testing authorities (**IEC 60904-9, ASTM E927 / ASTM E72-10, and JIS C8912**):



- **Spectral Match (Class A):** Rigorously matches the structural spectral distribution requirements of the AM 1.5G global standard across the $400\text{ nm} \text{ to } 1100\text{ nm}$ range, suppressing spectral mismatch errors.

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- **Spatial Uniformity of Irradiance (Class A):** Delivers a uniform illumination field across active test zones up to $50 \times 50\text{ mm}$ ($2 \times 2\text{ inches}$ at 1 Sun), providing equal photon distribution across the complete device active area.
- **Temporal Stability (Class A):** Continuous optical spectrum output guarantees a drift-free operational state during sensitive, multi-hour lifecycle tests or transient fast-sweep data acquisition.

3. ADVANCED ELECTRICAL & HARDWARE SPECIFICATIONS

The system leverages an integrated control approach, with internal modules communicating over high-speed USB channels to eliminate data bottlenecks.

3.1. Precision Source Measure Unit (SMU)

- **Voltage Sweeping Enclosure:** Fully programmable DC sweep window covering **-7V to +7V** with fine step scaling.
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- **Dynamic Current Range:** Highly sensitive operational range operating from an ultra-low threshold of **1nA** up to a robust **30 mA** capacity, capturing small leakage paths as well as standard operational outputs.
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- **Measurement Modes:** Complete dual-state compatibility supporting both Dark and Illuminated I-V plots for exact series/shunt isolation.
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3.2. Solar Light Controller & Irradiance Regulation

- **Wide Irradiance Spectrum:** Programmable light intensity control operating from **0.1 W/m2 to 1000 W/m^2** with any step of W/m^2
- **Fine Step Optimization:** Computer-driven automatic shuttering and software attenuation allow adjusting light levels in fine **0.1 W/m2 to 1000 W/m^2** with any step of W/m^2

- **Calibrated Reference Cell:** Supplied with an accredited, factory-calibrated reference solar cell to guarantee daily traceability for absolute light intensity matching.

4. MULTI-MODULE AUTOMATION SOFTWARE PLATFORM

The X-11 system features four specialized software modules operating in real time to handle everything from standard efficiency testing to advanced physical mechanism diagnostics.

Module 1: Solar IV Characterization Software

Automates standard I-V and P-V acquisition sequences to calculate primary photovoltaic figures of merit:

- $\mathbf{V_{oc}}$ (Open-Circuit Voltage) & $\mathbf{I_{sc}}$ (Short-Circuit Current / Current Density)
  $\mathbf{P_{max}}$ (Maximum Power Output) with exact $\mathbf{V_{max}}$ and $\mathbf{I_{max}}$ coordinates
- **FF** (Fill Factor) & PCE (Photovoltaic Power Conversion Efficiency)
- $\mathbf{R_s}$ (Series and $\mathbf{R_{sh}}$ Shunt Resistance parameters derived via internal diode-slope models)
- $\mathbf{R_{ch}}$ (Characteristic Device Resistance) & RR (Photoresponse / Photosensitivity coefficients)

Module 2: Solar Life-Time & Stability Software

Designed for long-term aging setups and material lifetime tracking. It logs continuous performance stability curves and open-circuit/short-circuit parameters over time to quantify degradation rates under controlled atmospheric exposures.

Module 3: Transient Photocurrent Software (I-t Module)

Enables precise time-resolved current profiling (I-t). It measures fast carrier transport phenomena and decay processes under dynamic illumination changes, which are vital for understanding charge collection dynamics in thin-film architectures.

Module 4: Photovoltaic Mechanism Analysis Software

This diagnostic engine maps short-circuit current curves against variable light levels (Isc vs. Light Intensit and lnI). It by passes manual graphing steps and automatically identifies the dominant carrier loss mechanisms directly on screen, such as:

- **Monomolecular Recombination** limitations.
- **Supra-linear Recombination** pathway patterns.
- Lokal device recombination bottlenecks and diode ideality factor (n) indices.

5. TECHNICAL SPECIFICATION

Feature Grouping	**Equipment Specifications**
Solar Simulator Output	Class AAA Certified (IEC 60904-9, ASTM E927, JIS C 8912)
Reference Standard Standard	AM 1.5G Continuous Filtered Spectrum
Controllable Irradiance Span	**0.1 W/m2 to 1000 W/m^2** with any step of W/m^2
Testing Area	Up to 50 mm (2 inches) at 1 Sun
System Measurement Modes	I-t and V-t (Transient Photocurrent), Long-Term Stability, Mechanism Analysis
SMU Potential Span	-9V to + 9V

Feature Grouping	Equipment Specifications
SMU Current Range	1Na-30 Ma
Digital Connectivity	Plug-and-Play USB 2.0 / 3.0 Control Interface
Calibration Architecture	Factory-certified AM1.5G match tracking reference cell

6. REGULAR LAB & TECHNICAL APPLICATIONS

- **Photovoltaic Material R&D:** Direct screening of physical parameters in newly synthesized molecular chains, absorber films, and carrier transport windows.
- **Device Level Quality Control:** Standardized, repeatable classification of cell batches before scaling up module integration.
- **Advanced Recombination Modeling:** Direct software-guided extraction of underlying electronic bottlenecks, avoiding slow post-processing routines.
- **Academic Labs & Training:** A safe, automated, and comprehensive tool set tailored for graduate programs in Solid-State Electronics, Materials Engineering, and Applied Electrochemistry.

CERTIFICATE OF COMPLIANCE ABSTRACT

Product Identification: Solar Simulator & Photovoltaic Testing Platform

Model Identity: SOLAR TECH X-11 Series

Accreditation Metric: Fully certified compliant for Spectral Fit matching under **ASTM E72-10, IEC 60904-9, and JIS C 8912** guidelines for AM 1.5G distributions. Certified and signed by the General Management division of *Solar Physics Technologies (Issued 07.08.2025)*. All structural calibrations are verified at the production point and are ready for turn-key facility commissioning. Standard commissioning, integration, and user group training modules are included.