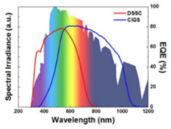
SOLARPHYSICS TECHNOLOGIES



SOLAR SIMULATOR TECHNOLOGIES

MADE IN U.S.A.

QUANTUMSOL AXON

Full Automatic Solar Simulator

IV and CV System

The QUANTUMSOL AXON is a **fully automatic AAA-class solar simulator IV and Impedance characterization system** designed for high-precision **I–V, P–V, and photovoltaic mechanism analysis** of all types of solar cells. The system provides **computer-controlled operation**, automatic light intensity adjustment, and fully automated measurement of **key photovoltaic parameters** under variable illumination conditions.

Solar Simulator IV Characterization System

Spectral Solar Irradiance Matching – AAA Class

System Overview

The **LSS Solar Simulator IV Characterization System** is a complete **photovoltaic characterization platform** for advanced laboratory and research applications. Designed for accurate and repeatable measurement of **I–V, I-t, and P–V characteristics**, it supports a wide range of solar cell technologies including:

- Dye-Sensitized Solar Cells (DSSC)
- Quantum Dot Solar Cells (QDSC)
- Organic Solar Cells (OSC)
- Perovskite Solar Cells
- Silicon Solar Cells
- Thin-Film Solar Cells

The system operates under **adjustable solar light intensities** from **0.1 W/cm² to 1500 W/m²**, providing a fully controlled environment for **current-voltage, current-time, and power-voltage measurements**.

System Includes

1. **AAA Class Solar Simulator** – Maintenance-free, high stability, factory-calibrated for AM1.5G spectral match
2. **Precision Sourcemeter** – Voltage range: **-9 V to +9 V**, Current range: **1 nA to 30 mA**
3. **Solar Light Controller** – Ensures precise and stable irradiance output
4. **Automatic IV Measurement Controller** – For programmable measurement sequences
5. **Calibrated Reference Solar Cell** – Factory calibrated for intensity and spectral match
6. **Sample Holder** – Adjustable for multiple orientations, including 0°–90° rotation
7. **Software Suite**

Software Suite

The system includes multiple software modules for complete photovoltaic analysis:

- **Solar IV Characterization Software** – Automated I–V and P–V measurements
- **Solar Life-Time Software** – Long-term solar cell stability analysis
- **Transient Photocurrent Software** – Time-resolved photocurrent measurements (I-t)
- **Photovoltaic Mechanism Analysis Software** – Detailed analysis of PV mechanisms

Key Features

- **Universal Solar Cell Compatibility:** DSSC, QDSC, OSC, Perovskite, Silicon, Thin-Film
- **Irradiance Range:** 0.1 W/cm² to 1500 W/m²
- **Illumination Area:** 2” x 2” at 1 Sun
- **PV Cell Placement Indicator:** Ensures precise alignment
- **Adjustable Orientation:** Can be mounted pointing up, down, or sideways with 90° rotational accessory
- **Temperature-Controlled Simulator:** Stable output under varying laboratory conditions
- **USB Communication:** Easy interface with control software
- **Standards Compliance:** Class AAA for **IEC 60904-9**, **JIS C 8912**, and **ASTM E 927**
- **Easy Light Adjustment:** Fine-tune solar intensity with the controller

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Electrical & Measurement Specifications

Sourcemeter

- **Voltage Range:** -9 V to +9 V
- **Current Range:** 1 nA to 30 mA
- **Measurement Capabilities:**
  - I–V (Current-Voltage)
  - I-t (Current-Time / Transient Photocurrent)
  - P–V (Power-Voltage)
- **Calibration:** Factory-calibrated reference solar cell for AM1.5G spectral match and irradiance intensity

Impedance analyzer

Advanced C-V & Semiconductor Analysis

- **Capacitance-Voltage (C-V):** Characterize doping profiles and threshold voltages for diodes, photodiodes, and solar cells
-
- **Measurement Modes:** Supports **Amplitude**, **Constant Voltage**, and **Constant Current** sweeps.

Comprehensive Parameter Measurement

The system simultaneously measures and analyzes parameters in both **Series** and **Parallel** modes:

- **Impedance (Z):** Magnitude |Z|, Phase Angle theta, Series/Parallel Resistance (R_s, R_p), and Reactance (Xs, Xp).
-
- **Admittance (Y):** Magnitude |Y|, Conductance (G_s, G_p), and Susceptance (B_s, B_p).

- **Capacitance & Inductance:** C_s, C_p, L_s, L_p.
- **Loss Factors:** Dissipation factor (D or tanδ) and Quality factor (Q)

Nyquist Measurements

Bode Measurements

Wide Frequency Dynamics

- **Frequency Range:** 1mHz to 25 MHz
- **EIS vs. Frequency:** Real-time measurement of real and imaginary forms of impedance, conductance, and capacitance.

Votlage range: -5 V to 5 V adjustable

Applications

- Research & development of advanced solar cells
- Photovoltaic device quality control
- Laboratory teaching & experiments
- Stability and lifetime studies of solar cells
- Comparative studies of emerging photovoltaic technologies

Automatic Solar IV Characterization System

Class AAA Solar Simulator – High-Precision Photovoltaic Characterization

System Overview

The **Solar Simulator System** generates a continuous **AAA-class light spectrum** for precise characterization of all types of solar cells. The system is capable of illuminating devices up to **50 × 50 mm or larger**, with adjustable light intensity ranging from **1 W/m² to 1000 W/m²**.

The **solar simulator and I–V measurement system** are fully **computer-controlled**, enabling automated measurement, analysis, and reporting of photovoltaic parameters and mechanisms.

Key Measurement Capabilities

I–V Characterization

- Dark and illuminated I–V measurements for analysis of series resistance, shunt resistance, diode factor, and saturation currents
- Light I–V measurements for standard photovoltaic characterization

Power-Voltage (P–V) Measurement

- Simultaneous acquisition of **current-voltage** and **power-voltage curves** under variable illumination

Photovoltaic Mechanism Analysis

- Automatic determination of mechanisms including **monomolecular recombination, supra-linear mechanisms**, etc.
- Real-time identification of the dominant mechanism on the computer screen

Photovoltaic Parameters Measured Automatically

- Open Circuit Voltage (**Voc**)
- Short Circuit Current (**Isc**)
- Maximum Power Output (**Pmax**)
- Voltage at Pmax (**Vmax**)
- Current at Pmax (**Imax**)
- Fill Factor (**FF**)
- Series Resistance (**Rs**)
- Shunt Resistance (**Rsh**)
- Characteristic Resistance of Solar Cell (**Rch**)
- Photoresponse (**RR**)
- Conversion Efficiency (**η**)

System Automation Features

- Computer-controlled **automatic solar simulator**
- Automatic intensity adjustment from **0.1 W/cm² to 1000 W/cm²** with **1 mW/cm² steps**
- Automatic measurement of:
    - I–V curves
    - P–V curves
    - I–sc vs. solar light intensity
    - Photovoltaic mechanism analysis
- Automatic data analysis and real-time display of mechanism type

Technical Specifications

Feature	Specification
Solar Simulator Control	Fully computer-controlled
Light Intensity Range	0.1 W/cm² – 1000 W/cm², adjustable in 1 mW/cm² steps
Measurement Modes	I–V, P–V, Isc-Light Intensity, Photovoltaic mechanism analysis
Source Meter	Voltage: -9 V to +9 VCurrent: 1 nA – 30 mA (or higher)
Automatic Shuttering	Light intensity automatically adjusted 1–1000 W/m²
Software	Complete measurement, data acquisition, and analysis
Sample Size	Up to 50 × 50 mm
Installation & Training	Included

Applications

- Laboratory-scale photovoltaic research and development
- Characterization of Dye-Sensitized, Quantum Dot, Organic, Perovskite, Silicon, and Thin-Film Solar Cells
- Long-term stability and lifetime testing
- Advanced photovoltaic mechanism studies

System Highlights

- **AAA-class spectrum** for accurate AM1.5G simulation
- **Continuous light spectrum** with adjustable irradiance
- Fully **automated I–V and P–V measurements**
- Automatic **photovoltaic mechanism identification**
- User-friendly **software interface** for real-time analysis
- Suitable for **research labs, universities, and industrial R&D**

System Software

The **Solar Simulator System** is equipped with two advanced software modules for **complete photovoltaic characterization**:

1. Photovoltaic Parameter Characterization Software

This software automates the measurement and calculation of **all key photovoltaic parameters** of solar cells. The system performs measurements and determines the following parameters:

- **Short Circuit Current (Isc)**
- **Open Circuit Voltage (Voc)**
- **Maximum Power (Pmax)**
- **Current at Maximum Power (Imax)**
- **Voltage at Maximum Power (Vmax)**
- **Conversion Efficiency (η)**
- **Shunt Resistance (Rsh)**
- **Series Resistance (Rs)**

The software provides **real-time plotting**, data acquisition, and export functions for laboratory and research applications.

2. Photovoltaic Mechanism Analysis Software

This software module **automatically analyzes the photovoltaic mechanisms** of the solar cell under test. It can identify dominant mechanisms such as:

- Monomolecular recombination
- Supra-linear recombination
- Other device-specific recombination processes

Results are displayed directly on the computer interface, enabling **fast, automated analysis** and **mechanism classification** without manual intervention.

3. Impedance analyzer Measurements

Advanced C-V & Semiconductor Analysis

- **Capacitance-Voltage (C-V):** Characterize doping profiles and threshold voltages for diodes, photodiodes, and solar cells
- **Measurement Modes:** Supports **Amplitude**, **Constant Voltage**, and **Constant Current** sweeps.

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- **Loss Factors:** Dissipation factor (D or tanδ) and Quality factor (Q)
  Nyquist Measurements
  Bode Measurements

Wide Frequency Dynamics

- **Frequency Range:** 1mHz to 25 MHz
- **EIS vs. Frequency:** Real-time measurement of real and imaginary forms of impedance, conductance, and capacitance.

Certificate of Compliance

Product Information

- **Product:** Solar Simulator
- **Serial Number (SN):** 112

Applicable Standards

This product has been evaluated and found to comply with the following international standards:

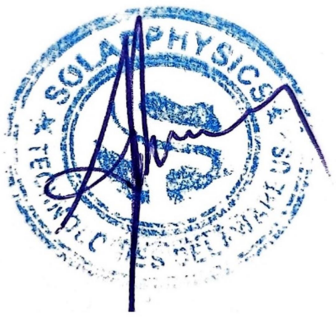
- **ASTM E72-10**
- **IEC 60904-9**
- **JIS C 8912**

Compliance Scope

- **Spectral Fit:** ✓ Compliant
- Conforms to spectral distribution requirements for **AM 1.5G** solar simulation
- Meets Class-A spectral matching criteria as defined in the applicable standards

Statement of Compliance

The Solar Simulator **SOLAR TECH X-11** has been tested and verified to comply with the above-mentioned standards and fulfills the required criteria for **spectral fit performance** in photovoltaic measurements.



Authorized Signature:

Title: General Manager
Organization: Solar Physics Technologies

Date: 07.08.2025