

LED'S COPY THE SUN.



The SINUS-220 is the ideal solar simulator for production, research and certification. Its nearly perfect simulation of the sun's spectrum enables highly accurate solar cell efficiency measurement. The intelligent LED-based light source is what makes this exceptional accuracy possible. LED's present the new benchmark:

FEATURES

- › 21-color LED-based light source
- › Special lens system for perfect color mixing
- › Built-in spectrometer
- › Auto-calibration of spectrum and intensity
- › Long exposure times for high-efficiency solar cells
- › Fully integrated IR and EL cameras
- › Automatic detection of hotspots
- › Intuitive, ergonomic user interface
- › Exceeds class AAA criteria

BENEFITS



LED'S MEASURE ACCURATELY

The SINUS-220's accurate and precise simulation of the sun's spectrum minimizes the danger of classifying solar cells with an incorrect efficiency rating. This eliminates the necessity of safety margins.



LED'S INCREASE EFFICIENCY

Production process instabilities are uncovered rapidly and consistently. New processes developed in the lab can be more quickly and easily integrated into the production process.



LED'S FLASH LONGER

The light source of the SINUS-220 enables long exposure times. The efficiency of high-performance solar cells can thus be accurately measured.



LED'S REDUCE RUNNING COSTS

The SINUS-220 can provide 24 months of reliable operation with minimal maintenance. Consequently, operating costs (replacement part and personnel costs) and production downtime are significantly reduced.



LED'S BOOST ENERGY YIELDS

The SINUS-220 makes it possible to vary the spectrum in order to sort or specifically optimize solar cells according to the regions they will be used in.



LED'S EXTEND MODULE LIFE

The next generation of the SINUS-220 will detect hotspots with an innovative process that takes into consideration all the physical processes involved.

CLASSIFICATION

	SINUS-220		Class AAA requirements
Spectral Match	Class A++	0.95 – 1.05	0.75 – 1.25
Non-uniformity of intensity	Class A+	1 %	2 %
Short-term instability of intensity (STI)	Class A	Synchronized	Synchronized
Long-term instability of intensity (LTI)	Class A+++	< 0.2 %	2 %
Non-uniformity of mismatch factor		< 0.1 %	Under discussion
Long-term instability of mismatch factor		< 0.05 %	Under discussion

Validity of classification:

1 sun, AM1.5, 250 ms, 16 × 16 cm², 74 cm between light engine and solar cell, WPVS cells ISE021/030-2014 and ISE022/034-2014

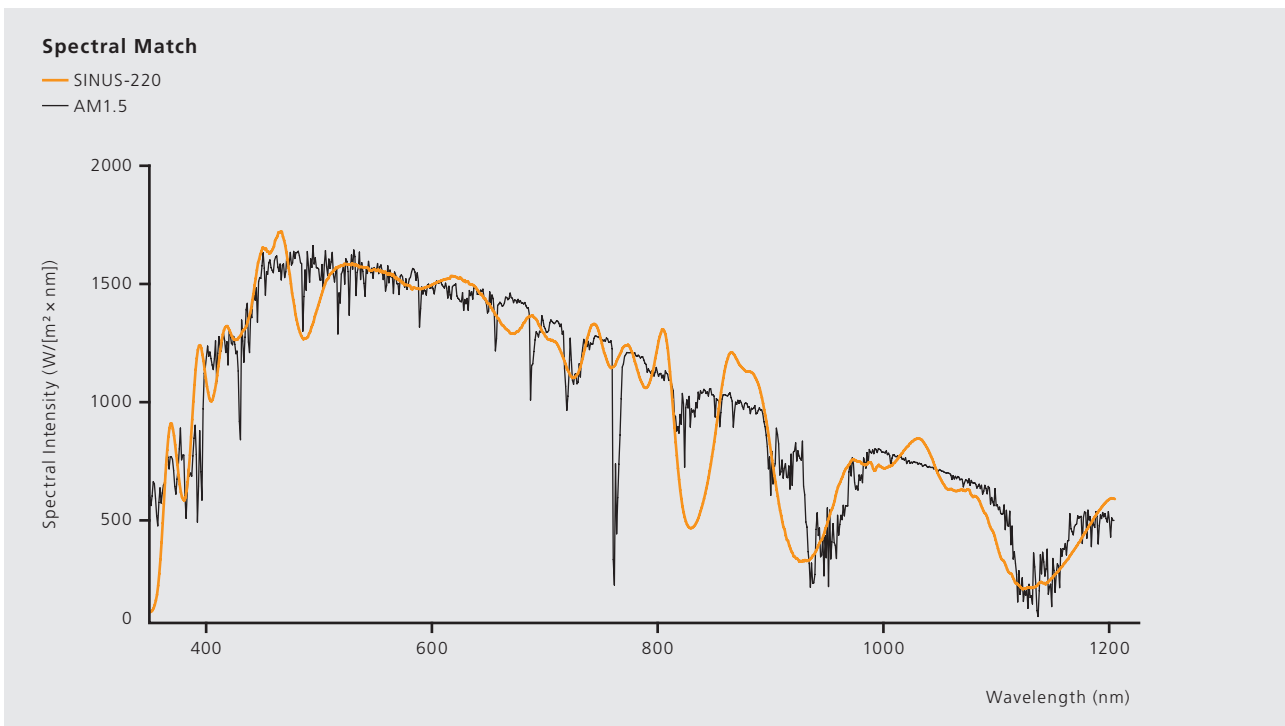
SPECTRAL QUALITY

Spectral match with AM1.5 spectrum for the range from 400 nm up to 1,100 nm. This is the conventional definition of the spectral match according to IEC 60904-9.

Wavelength range (nm)	SINUS-220	AM1.5
400 – 500	18.4 %	18.4 %
500 – 600	19.9 %	19.9 %
600 – 700	18.4 %	18.4 %
700 – 800	14.9 %	14.9 %
800 – 900	12.5 %	12.5 %
900 – 1,100	15.9 %	15.9 %

Spectral match for the extended AM1.5 spectrum from 300 nm to 1,200 nm. The extension of the spectrum is important for high-efficiency solar cells.

Wavelength range (nm)	SINUS-220	AM1.5
300 – 400	5.5 %	5.5 %
400 – 500	16.7 %	16.7 %
500 – 600	18.1 %	18.1 %
600 – 700	16.7 %	16.7 %
700 – 800	13.5 %	13.5 %
800 – 900	11.3 %	11.3 %
900 – 1,000	6.7 %	6.7 %
1,000 – 1,100	7.7 %	7.7 %
1,100 – 1,200	3.8 %	3.8 %



FUNCTIONALITY

IV curve measurement	Dark and under illumination, from –20V to 8V, from –20A to 20A
Solar cell parameter analytics	Voc, Isc, FF, Pmpp and efficiency
Temperature correction	Solar cell parameters are adjusted according to IEC 60904-5, IEC 60891
Series resistance analytics	Based on IEC 60891 with IV curves measured at two irradiance levels
Shunt resistance analytics	Based on reverse dark current
IV curve fitting	Based on one or two diode model
Fully integrated and synchronized infrared (IR) camera	IR camera and IV electronics are synchronized so that current measurement and IR image are recorded at the same time. Patented method for reduced false/true and true/false binning
Fully integrated electroluminescence (EL) camera with image processing software	Micro-crack detection and wafer inspection
Red-blue routine	Illumination with only blue and red light (or other colors) allows the fast detection of process instabilities
EQE routine	Fast inline measurement of external quantum efficiency (EQE) by using single LEDs
Variable spectrum	User can easily define spectra other than AM1.5 for yield tests under non-standard operating conditions
SunsVoc	Fast inline method for measurement of ideal FF without impact from series resistance. LED light engine reduces change of mismatch factor during measurement
Busbar-busbar check	Fast inline method for detection of finger print interruptions or other series resistance issues
Pin-pin check	Fast inline method for pin quality check and alignment check of contact bars
Conditional measurement	User can define threshold value, which automatically triggers special measurement
User defined analytics	Open software interface allows export of all measured data for analysis and import of classification criteria
User defined measurement recipes	SINUS-220 is shipped with standard measurement recipes. User can easily define new recipes via GUI

LIGHT ENGINE FEATURES

The light engine consists of individually controlled LEDs with 21 different peak wavelengths. A special optical lens system ensures perfect color mixing for each spot on the solar cell. Built-in spectrometer and reference solar cell in combination with automatic on-the-fly correction within milliseconds make daily re-calibration redundant.

Spectrum	AM1.5, AM0 or customer defined spectrum including illumination by single colors
Intensity range for AM1.5	As required: from 0.1 up to 1.2 suns
Intensity range for each single color	As required: from 10% up to 100%
Irradiance time	As required: from 2 ms up to continuous operation
Test area	160 × 160 mm ²
Distance light engine – solar cell	740 mm
Stabilization time after cold start	10 min
Stabilization time after LED box replacement	30 s
Cooling	Water cooling for high stability and long life span
LED box life span	2 years under standard inline operating conditions

IV ELECTRONICS FEATURES

The very fast active electronic load allows 4 quadrant measurements. A 14 bit calibrated analog-digital converter and a calibrated, traceable shunt resistor fulfill the highest demands for accuracy and precision.

Voltage resolution	0.025 % of 2 V or 20 V
Current resolution	0.025 % of 2 A or 20 A
Accuracy	< 0.08 %
IV curve measurement time	As required: from 2 ms up to 600 s
Sampling rate	Ca. 10 ⁶ /s
Data acquisition time per IV pair	As required: from 2 μs up to 10 s
Voltage between two adjacent IV pairs	As required: variable for each IV pair
Number of IV pairs per IV curve	As required: up to 5.000
Stabilization time after cold start	30 s

SYSTEM FEATURES

SINUS-220 is designed for high precision and low maintenance operation in high speed production lines. Alternatively, it can also be used offline in R+D laboratories or for certification.

Throughput	As required: up to 7,200 solar cells per hour and more (LED light engine does not require time for re-charging)
Sorting	As required: up to 256 classes
Communication for inline integration	Via hardware signals and RS232 or Profibus.
Control levels	Operator/Service/Admin level
User interface	Large touch screen, keyboard, mouse
Industrial PC	Windows, RAID 2
Temperature sensors	PT100, I2C, Pyrometer
Temperature resolution	14 bit, < 0.05 K
Chuck for offline measurement of solar cells at defined temperature	See separate data sheet
Infrared camera	See separate data sheet
Electroluminescence camera	See separate data sheet
Required environment	Less than 60 % humidity, non-condensing

SCOPE OF DELIVERY AND DIMENSIONS

Light engine	564 (740 with both cameras) × 688 × 477 mm ³ , 55 kg
Power supply	19" rack mount chassis, 3U
IV electronics and amplifier	19" rack mount chassis, 3U
Industrial PC	19" rack mount chassis, 4U
Chiller	320 × 500 × 600 mm ³
Options	<ul style="list-style-type: none"> › Fully integrated infrared camera › Fully integrated electroluminescence camera › Pyrometer for inline temperature measurement › UPS › Chuck for offline measurement of solar cells at defined temperature › Rack for offline installation in laboratory

Specifications subject to technical changes, SINUS-220 2015_03_20

CONTACT

WAVELABS Solar Metrology Systems GmbH | Markranstädter Str. 1 | 04229 Leipzig | Germany | +49 341 4924 4830 | www.wavelabs.de