



CetisPV-Celltest4-BF

Class AAA+ high-precision lab tester to measure bifacial (BF) solar cells

CetisPV-Celltest4-BF provides the possibility to measure monofacial and bifacial solar cells using different illumination levels for their rear and front side. Using two synchronized class AAA+ Xenon flashers, flexible flash profiles can be applied within one measurement sequence. This enables the measurement under front and rear STC conditions, as well as typical field conditions for bifacial solar (e.g. 1.000Wm²(front) and 200Wm²(rear)).

CetisPV-Celltest4-BF is designed for high-end R&D, laboratory and quality control demands. Its solar simulator provides a highly stable irradiance overlong flash duration. Combined with the well-known halm IV curve tracer and halm single-flash advanced hysteresis to measure high-capacitance solar, this system is designed to match the demands of current and up-coming cell technologies. Our applicant software **PVControl** offers one-click solutions for parameter adaptations and the recipe-based storage of settings, including polarity switching and customized evaluations using user-defined formulas.

The standard IV measurement system can be complemented by further tools for quality and process control such as electroluminescence or infrared imaging, in line spectral response and grid resistance.

Technical Specifications

Sun Simulator

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|---|---|---|----------------------|
| Irradiance | 200... 1.100Wm ² | | |
| Illumination area | ≥240mm X 240mm | | |
| Flash duration (bifacial) | Rear: 1.000Wm ² | 200Wm ² | |
| | Front: | 1.000Wm ² | 1.000Wm ² |
| | Up to 3 x 40 ms: | 40ms | 40ms 40ms |
| | With a repetition rate of 4 s | | |
| Flash profiles | Up to 3 x 60 ms ¹ : | 60ms | 60ms 60ms |
| | With an additional power booster cetisPV-XF3-PB and a repetition rate of 8 s | | |
| | Flash profiles | Single level for standard IV curve, intensity ramp for SunsVoc option only monofacial: double or triple level for series resistance determination according to IEC 60891 | |
| | Spectral match ² | Front: 0,875 – 1,125 at 1.000 Wm ² (class A+) / rear: 0,75 – 1,25 (class A) | |
| Non-uniformity of irradiance ² | <2 % ³ at 1.000Wm ² (class A) | | |
| Short-term instability of irradiance ² | <0,05 % at 1.000Wm ² (class A+ ≤ 0,25 %) | | |
| Long-term instability of irradiance ² | <0,08 % at 1.000Wm ² (class A+ ≤ 1 %) | | |
| Guaranteed lamp lifetime | Up to 2 years for flashes with a flash duration of 80ms or 3 x 40 ms and a repetition rate of 4 s | | |
| Lamp type | Xenon tube | | |

¹ Preliminary

² IEC 60904-9:2020 Ed 3

³ measured without contact bars

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| Measurement system | |
| IV measurement types | Light forward, dark revers, dark forward (low current), dark forward (high current), advanced hysteresis, measured IV curve can be exported in ASCII format (optional: SunsVoc, 2-diode analysis) |
| Repeatability ⁴ | Isc, Voc: $\sigma < 0,1 \%$ / Pmpp FF: $\sigma < 0,15 \%$ |
| Measurement resolution | $< 0,0004 \%$ FSR (4 synchronous 16-bit channels for voltage, current, and 2 x irradiance) |
| Measurement accuracy | $< 0,05 \%$ FSR for current and voltage measurements |
| Voltage measurement ranges | $\pm 1 \text{ V} / \pm 2 \text{ V} / \pm 4 \text{ V} / \pm 10 \text{ V} / \pm 16 \text{ V}$ / or $\pm 1 \text{ V} / \pm 2 \text{ V} / \pm 4 \text{ V} / \pm 10 \text{ V} / \pm 120 \text{ V} / + 12\text{V}$ |
| Current measurement ranges | $\pm 2,5 \text{ V} / \pm 5 \text{ V} / \pm 12,5 \text{ V} / \pm 25 \text{ A}$ $\pm 16 \text{ mA} / \pm 32 \text{ mA} / \pm 80 \text{ mA} / \pm 160 \text{ mA}$ |
| Measurement points | Up to 1,024 for every type of measurement |
| Measurement parameters (subset of more than 500 available parameters) | Bifacial Isc, bifacial Voc, Bifacial Eta, bifacial Pmpp, bifaciality coefficients Isc (short – circuit current), Jsc (Short-circuit current density), Uoc (open-circuit voltage), FF (fill factor), Eta (efficiency), Pmpp (maximum power), Impp (current at maximum power point), Jmpp (current density at maximum power point), Vmpp (voltage at maximum power point), series and shunt resistance (various determination methods), Irev (reverse current) |
| Irradiance sensor | Encapsulated 20 mm x 20 mm crystalline Si cell including integrated temperature sensor Measurement certificate for linearity with respect to irradiance and temperature coefficient |
| Temperature measurement | Contactless temperature measurements using a pyrometer Repeatability: $\pm 0,5 \text{ K}$ |
| Electronic load | Active 4-quadrant load |
| System calibration | Calibration with calibrated reference solar cell (reference cells not included) |
| Contacting station | |
| Feature | Hand-operated bifacial contacting station |
| Solar cell layouts | From 150 mm x 156 mm up to 220 mm x 220 mm |
| Operation control system | |
| Software features | Fully controlled measurement procedures and evaluations Automatic calibration Classification with up to 256 BINs |
| Recipes managements for | Measurement types Cell types Calibration cells Flash profiles |
| GUI feautres | Customizable display of measurement results Display of device status |
| Data storage | Database support for MySQL, ACCESS, MS-SQL, Postgres ASCII files for raw curve data |
| Measurement PC | PC, 8 GB Ram, 2x2 TB hard disk (RAID), 19" monitor, keyboard, mouse, Windows 10 (English) |

⁴ FAT repeatability tests test is if the relative standard deviation σ of 20 measurements without recontacting of the cell is less than standard deviation.

General information

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| Dimensions | Dark chamber with contacting station and flash boxes (880 mm x 780 mm x 2.400 mm) Control cabinet (550 mm x 780 mm x 1.675 mm) or 2 x (550 mm x 780 mm x 1.300 mm) |
| Weight | Dark chamber with contacting station (<170 Kg) |
| Noise level | Control cabinet 70dB (A) |
| Power requirements | 3-Phase (3L + N + PE) 400 Vac \pm 10 % / 50 or 60 Hz \pm 1 % ; 10kVA; 16 A (Slow-blow fuse) ⁵ |
| Required ambience conditions | Indoor use only at or below 2.000m AMSL 15°C – 35°C; 0 % ... 80% Relative humidity (noncondensing) |
| Documentation | User Manuel (English) |
| Certification for solar simulator (IEC 60904-9:2020 Ed. 3) | Spectrum measurement, non-uniformity measurement, temporal stability measurement |
| Calibration certification | Factory calibration protocol for measurement channels: I, V, irradiance, temperature |

⁵ fuse protection depending on requirements and statutory regulations at set-up location.

Dimensions and integration of the CetisPV-Celltest4-BF

CetisPV-Celltest4-BF consists of a dark chamber with 2 flasher units and contacting station as well as the curve trace, the measurement PC and units to control the sun simulator.

