



## CetisPV-Modultest4

Class A+A+A+ high-precision lab tester for IV measurements of solar cells

The **CetisPV-Modultest4-BF** is an IV measurement system developed to high-end R%D, laboratory and quality control demands that allows the measuring of solar modules based on all cell technologies including TOPCon and HJT.

The programmable pulsed solar simulator with the **CetisPV-MB-G2** flash unit provides a highly stable irradiance over long flash durations from a single light source. It ensures class A+A+A+ at irradiances from 500Wm<sup>2</sup> to 1.300Wm<sup>2</sup>. The range of irradiances can be expanded to 100Wm<sup>2</sup> to 1.300Wm<sup>2</sup> with the optional neutral density filter **CetisPV-NDF2**.

Combined with the halm IV curve tracer and halm's single-flash advanced hysteresis method **PVControl-SF-hyst** to measure high-capacitance modules, this system is designed to meet demands of current and upcoming solar cell and module technologies.

The versatile system can be equipped with different hard and software options such as dark IV, The electroluminescence imaging solution or temperature-controlled test chamber.

### Technical Specifications

Sun Simulator	
Irradiance	500Wm <sup>2</sup> ... 1300Wm <sup>2</sup> With optional cetisPV-NDF2: 100Wm <sup>2</sup> ... 1300Wm <sup>2</sup>
Illumination area <sup>1</sup>	2700mm X 1600mm
Flash duration	45ms single level flash, up to 110ms
Repetition rate	20 s for 45ms single level flash for standard illumination area
Flash profiles	Single level for standard IV curve Double or triple level for series resistance determination according to IEC 60891
Spectral match <sup>2</sup>	0,875 – 1,125 (class A+)
Non-uniformity of irradiance <sup>2</sup>	<1 % (class A+)
Short-term instability of irradiance <sup>2</sup>	<0,05 % (class A+)
Long-term instability of irradiance <sup>2</sup>	<0,08 % (class A+)
Lamp lifetime (Guaranteed/typical)	100.000 / 300.000 flashes for flash duration of 30ms every 20s
Lamp type	Xenon tube

<sup>1</sup> different size on demand

<sup>2</sup> IEC 60904-9:2020 Ed.3

Dark chamber	
Features	Walk-in side-access with curtain inside fully coated with low-reflection surface Strong aluminum frame Holding system for easy module positioning Turnkey installation
Measurement system	
IV measurement types <sup>3</sup>	Light forward, multi-level IV measurements, sectional measurement, advanced hysteresis in one or two flashes
Repeatability <sup>4</sup>	Isc, Voc: $\sigma < 0,1 \%$ / Pmpp, FF: $\sigma < 0,15 \%$
Measurement resolution	$< 0,004 \%$ FSR (3 Synchronous 16-bit channels for voltage, current, and irradiance)
Measurement accuracy	$< 0,05 \%$ FSR (for current and voltage measurements)
Current measurement ranges	+2,5A / +5A / +12,5A / +25 A +1 A / +0,5 / +0,2 A / +0,1 A
Measurement points	Up to 1,024 for every type of measurement
Measurement parameters (Subset of more than 500 available parameters)	Isc (Short-circuit current), Jsc (short-circuit current density), Uoc (open-circuit voltage), FF (fill factor), Eta (Efficiency), Pmpo (maximum power), Impp (current) at maximum power point, Jmpp (current density at maximum power point), Vmpp (voltage at maximum power point)
Irradiance sensor	Encapsulated 20mm x 20 mm crystalline Si solar cell Measurement certificate for linearity with respect to irradiance and temperature coefficient
Temperature measurement	Pyrometer for contactless temperature measurements PT100 sensor Repeatability $\pm 0,5 \text{ K}$
Electronic load	Active 2-quadrant load With optional cetis PV-EL3-M: 3 quadrant loads
System calibration	Calibration with calibrated reference solar module (reference module not included)
Interface to module	4-wire junction box with banana jacks Adapter cable MC4 and banana plugs (consumable parts)
Operation control system	
Software features	Fully controlled measurement procedures and evaluations Automatic calibration Classification with up to 256 BINs Barcode reader interface
Recipes managements for	Measurement types Module types Calibration modules Flash profiles
GUI features	Customizable display of measurements results Display of device status

<sup>3</sup> dark IV measurements available with the halm [CetisPV-EL3-M](#)

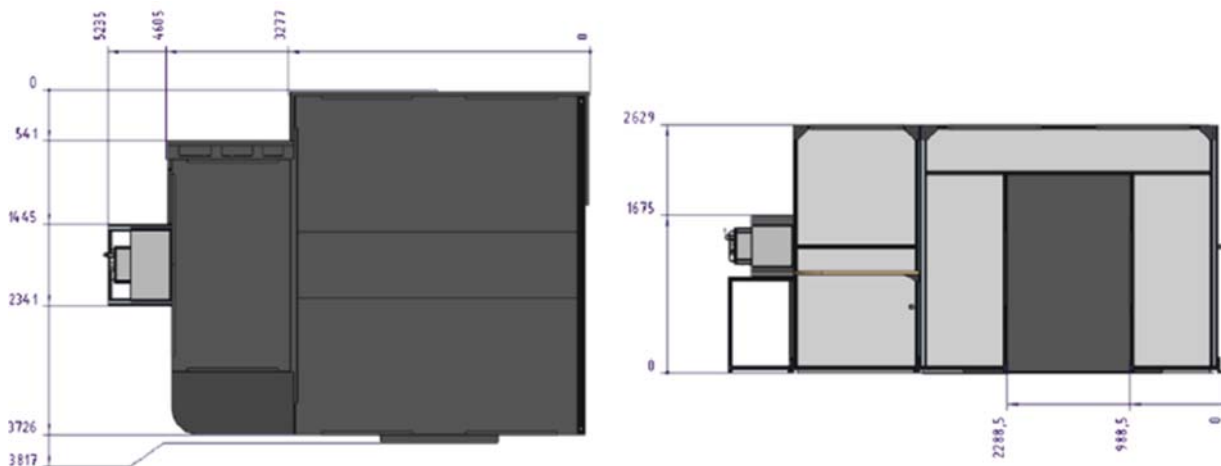
<sup>4</sup> FAT repeatability test: test is passed if the relative standard deviation  $\sigma$  of 20 measurements without of the module is less stated standard deviation

<sup>5</sup> different ranges apply for system equipped with [CetisPV-EL3-M](#)

Data Storage	Database support for MySQL, ACCESS, M-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)
<b>General information</b>	
Required space	6.000 mm x 4.700 mm x 3.200 mm
Dimensions	Control cabinet (550 mm x 780 mm x 1.660 mm) Flasher unit (810 mm x 670 mm x 720 mm) Uniformity panel (1.575 mm x 3.820 mm x 2.630 mm) Measurement chamber (5.250 mm x 3.820 mm x 2.630 mm)
Weight	Control cabinet (220 kg) Flasher unit (86 kg) Uniformity panel (30 kg) Measurement chamber (450 kg)
Noise level	< 60 dB (A)
Power requirements	3 Phase (3L + N+PE) 400 Vac $\pm 10\%$ / 50 or 60 Hz $\pm 1\%$ ; 10,5 kVA; 16 A (slow-blow fuse) <sup>6</sup>
Required ambient conditions	Indoor use only, at or below 1800 m AMS 15°C - 35°C; 0 %...80 % relative humidity (noncondensing)
Documentation	User manual (English)
Certificates for solar simulator (IEC 60904-9-2020 Ed.3)	Factory certificates for spectrum, non-uniformity and temporal stability
Calibration certificates	Factory calibration protocol for measurement channels; current, voltage, irradiance, temperature
System certificates	CE conformity declaration

<sup>6</sup> fuse protection depending on requirements and statutory regulations at set-up location

#### Dimensions of the cetisPV-Moduletest4



Dark chamber and flasher unit (left: from above; right: from side)