

PROFITEST | PV 1500

Peak Power Measuring Instrument and Curve Tracer for Capacitive Load at PV Modules and Strings

3-447-068-03
2/3.20

- Generator voltage up to 1500 V DC, current up to 20 A DC
- Measurement of short-circuit current I_{SC} , open circuit voltage U_{OC} , instantaneous peak power of a solar cell P_{max} , internal series resistance R_S and internal parallel resistance R_P
- Automatic conversion of momentary measured values to STC
- Patented calculation process for evaluating PV generators without knowledge of the manufacturer's specifications
- Patented calculation process for determining the generator's internal series resistance based solely on a single characteristic IU curve
- Separate measurement of temperatures at the irradiation sensor and the back of the module for increased measuring accuracy
- High level of intrinsic safety thanks to included load disconnect (1500 V/20 A DC) for all-pole disconnection of the measuring instrument from the PV generator
- Calibrated irradiation sensor per IEC/EN 60904-2 with integrated Pt1000 temperature sensor
- Integrated customer database with bidirectional data exchange
- Integrated module database with bidirectional data exchange
- Software for graphic representation, evaluation, error analysis and documentation with integrated database



Applications

The PROFITEST PV 1500 permits measurement of characteristic I-U curves for individual photovoltaic modules, and for strings as well.

With the help of a patented process, the instrument is capable of ascertaining peak power, internal series resistance and internal parallel resistance directly on-site **"with only one measurement and without entering module data"**, which are then displayed at a high resolution color graphic touch-screen which is suitable for use in sunlight. Troubleshooting in PV systems, as well as documentation of system quality, are executed quickly and economically during initial start-up and subsequent testing without a long learning curve. This simple yet decisive test assures safety for the customer and eliminates consequential costs for the installer. Measured peak power can, for example, also be used in order to determine performance ratio. Beyond this, acquired characteristic curves make it possible to draw further conclusions regarding the electrical characteristics of the measured module or string. And thus the instrument is also suitable for R&D.

Features

- Internal data memory for up to several thousand measurements
- The acquired characteristic I-U curve is highly accurate thanks to consistent measurement at the capacitive load.
- Displayed (calculated) values: peak power P_{Pk} , series resistance R_S , internal parallel resistance R_P , instantaneous values: U_{pmax} , I_{pmax} , P_{max} , U_{OC} , I_{SC} , FF, T_{mod} , T_{ref} , E_{RMS}

- Power and temperature measurement via four-conductor cable for error-free results
- Sensors for irradiation and temperature are integrated by means of analog technology with a rugged data transmission line. As a result, irradiation can always be measured in real-time, and irradiation fluctuations are reliably detected within the millisecond range. As a rule, measurement data cannot be transmitted continuously with solutions based on radio transmission, and thus only a snapshot is provided. However, irradiation typically changes by up to several hundred W/m^2 even in the millisecond range.
- Continuous display of momentary irradiation and temperature provides information regarding measuring conditions.
- The universal input permits use with commercially available irradiation reference sensors, assuring trouble-free on-site use of adapted sensors and sensor replacement.
- Operation of the PROFITEST PV 1500 via a PC with direct import of results (e.g. for continuous measurements)
- External power pack with broad-range input for charging the batteries, and for continuous operation of the measuring instrument
- Open interfaces permit operation of the instrument in special applications as well
- High level of intrinsic safety thanks to included load disconnect (1500 V / 20 A DC)

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Regulations and standards in accordance with which the test instrument is manufactured and tested:

IEC 61010-1/EN 61010-1/ VDE 0411-1	Safety requirements for electrical equipment for measurement, control and laboratory use – General requirements
EN 60529 VDE 0470, part 1	Test instruments and test procedures Degrees of protection provided by enclosures (IP code)
DIN EN 61326-1 VDE 0843-20-1	Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements

Regulations and Standards for Use of the Test Instrument

IEC 62446-1 VDE 0126-23-1	Grid connected photovoltaic systems – Minimum requirements for system documentation, commissioning tests and inspection
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Characteristic Values

Standard Measuring Ranges			
Voltage [V]	Current [A]	Temperature	Irradiation
25, 100, 500, 1500	2, 5, 10, 20	-40 ... +120 °C with Pt1000	0 ... 1300 W/m ² (standard sensor)

The measuring ranges can be combined with each other.
The measuring instrument automatically selects the ideal measuring range.

Computer Section

Miniature industrial PC, real-time clock, no moving mechanical parts such as hard disks, fans etc.
A/D sampling rate: max. 100 kHz, resolution: 12-bit
Measuring accuracy for characteristic I-U curve better than 1%, peak power $\pm 5\%$
Data from several thousand measurements are automatically saved at the device permanently (flash memory)

Measuring Section

Sampling rate	Max. 100 kHz
Resolution	0.01 V ... 0.25 V, 0.005 A ... 0.001 A (depending on the selected measuring range)
Measuring accuracy	Better than 1% (as of 10 W)

Ascertainment of Peak Power

Tolerance	$\pm 5\%$
Reproducibility	$\pm 2\%$

Measurement duration for separate measurement of individual modules: > 20 ms (approx. 100 pairs of measured values), and thus the capacitive characteristics of the device under test have no influence on the measurement

- 4-conductor measurement cable to the generator prevents systematic voltage measuring errors
- Irradiation reference sensor (Phox) with integrated Pt1000 temperature sensor

- Supplementary measurement of temperature at the back of the module is possible (a second Pt100 input is provided)
- Commercially available reference sensors such as the ISET-Sensor[®] can be connected via interference-free cable connection
- Connection is only permissible to direct voltage sources with current limiting (e.g. photovoltaic generators)

Sensor Connection Pin Allocations

Temperature (external): 4 pin female chassis socket, Lumberg KVF40
Pin 1: current source + (~1 mA)
Pin 2: Pt100 +
Pin 3: Pt100 –
Pin 4: current source – (~1 mA)

Irradiance: 8 pin female chassis socket, Lumberg KVF81 (plug: SV81)
Pin 1: irradiance +
Pin 2: Pt1000 (reference) +
Pin 3: irradiance –
Pin 4: current source + (~1 mA)
Pin 5: current source – (~1 mA)
Pin 6: unused (do not connect)
Pin 7: unused (do not connect)
Pin 8: Pt1000 (reference) –

Ambient Conditions

Operation	0 ... + 50 °C
Storage	- 10 ... + 85 °C
Relative humidity	
Operation	10 to 90% (non-condensing), no condensation allowed
Storage	5% to 95%, no condensation allowed

Power Supply

Battery	Rechargeable lithium-ion battery, 11.25 V, 8850 mAh, 99.6 Wh (continuous operation: approx. 8 h)
Power consumption	approx. 40 W
External power pack	In: 90 to 263 V AC, 47 to 63 Hz, 60 W
	• Integrated charge controller for protection against overcharging and excessively depleting the battery • Charge level indication by means of pilot LED on the housing (status display on the PROFITEST PV 1500)

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Display



Display Color LCD with LED backlight
Resolution 480 x 272 pixels
Suitable for use in sunlight

Operation

- Menu driven via touch-screen directly at the instrument
- Operating and evaluation alternatively with Windows software
- Connection to the PC: Mini USB type B socket
- USB cable: Standard USB 2.0 cable

Mechanical Design

Protection IP 20
Dimensions W x H x D: 406 x 330 x 175 mm
Weight approx. 7.6 kg (without accessories)

Data Interface

The PROFITEST PV 1500 is equipped with the following inputs and outputs (all interfaces are located on the front panel, and are labeled):

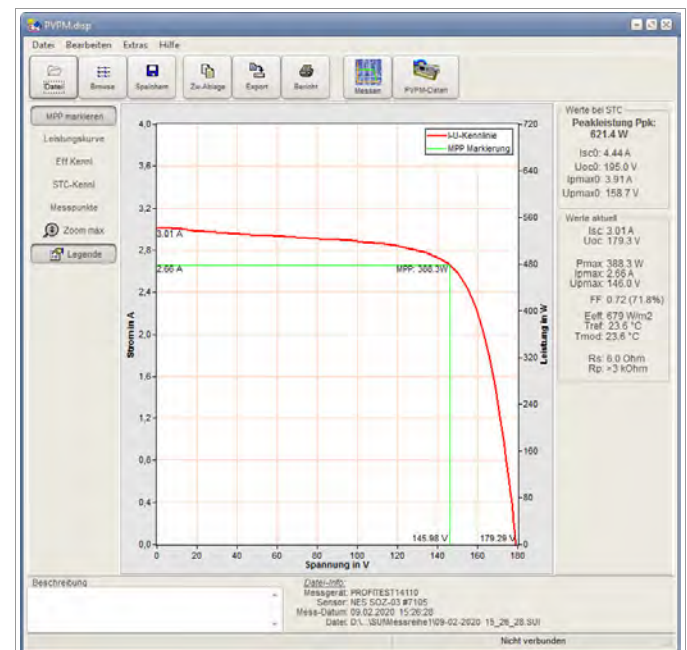
Interface	Function
Mains	External power pack: connection via barrel plug, 5.5 x 2.1 mm
Temperature	Connection for temperature sensor • Instruments with 2nd temperature measuring input: external Pt100 for acquiring temperature at the back of the module • Other instruments: external Pt100 or Pt1000 (depending on variant) for measuring temperature at the back of the reference cell
Irradiation	Connection for irradiation reference sensor (Phox) • The Pt100/Pt1000 reference sensor and the measured irradiation value are combined into a single 8-pin plug.
4-wire measurement	Measurement input (voltage measurement)
Current input	Power input (for current measurement)
PC	Connection via USB cable

Scope of Delivery

PC Software: PV Analyzer

Software for visualization, evaluation and documentation of measured characteristic curve values with database

- Measured characteristic curve values are read in from the PROFITEST PV 1500
- Graphic representation of the characteristic I-U curve
 - With calculated MPP – maximum power point (Pmax)
 - In comparison with the characteristic power curve
 - In comparison with the TRMS curve
 - In comparison with the STC curve
 - Characteristic I-U curve with display of measuring points
- Representation of measured and calculated values under STC
- Overview of characteristic IU curves for a given test series in the browser window
- Export of measured values or results (e.g. as XLS file)
- Generation of a test report (e.g. as a PDF file)
- Online measurement – graphic representation of the characteristic curve and measured values (also suitable for continuous measurement)
- Online access to the database and file management at the PROFITEST PV 1500
- Compatible with Microsoft® Windows® Vista, 7, 8 and 10



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Accessories

Irradiation reference sensor

Calibrated monocrystalline irradiation sensor, integrated Pt1000 temperature sensor, with retainer and 10 m connector cable



External Pt100 Temperature Sensor, 10 m long



External Safety Disconnecter

External load disconnecter (1500 V / 20 A) for all-pole disconnection of the measuring instrument from the PV generator



4-Conductor Measurement Cable, 10 m long

for connecting the load disconnecter and the PV generator



External Power Pack, 60 W

For supplying power to the PROFITEST PV 1500



Shielded Mini USB Cable

For communication between the PC and the PROFITEST PV 1500



Case System for Accessories



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Optionally available

PV Adapter Set MC3–MC4 (Z360K)



PV Adapter Set SUNCLIX–MC4 (Z360H)



PV Adapter Set TYCO–MC4 (Z360J)



Order Information

Description	Type	Article No.
Test instrument ¹ with TFT graphic display for ascertaining characteristic electrical values at PV modules and strings with up to 1500 V / 20 A per DIN EN 62446. With calibrated irradiation sensor and Pt1000 temperature sensor, external load disconnecter, measurement cables, USB cable, case for accessories and PV software	PROFITEST PV 1500	M360F
Optional Accessories		
Solar connector cable, length: 300 mm, cross-section: 4 sq. mm	PV adapter set MC3-MC4	Z360K
Solar connector cable, length: 300 mm, cross-section: 4 sq. mm	PV adapter set SUNCLIX-MC4	Z360H
Solar connector cable, length: 300 mm, cross-section: 4 sq. mm	PV adapter set TYCO-MC4	Z360J
Available upon request		
Extension cord for external Pt100 surface sensor, 10 m, for PROFITEST PV 1500	Extension cord for Pt100	
Extension cord for reference sensor with integrated Pt100 temperature sensor, 10 m, for PROFITEST PV 1500	Extension cord for reference sensor	

¹ Including factory calibration certificate, DAkS calibration certificate available as option