GOSSEN METRAWATT
GMC-INSTRUMENTS GROUP

OPERATING INSTRUCTIONS

1/12.24
3-447-273-03



PROFITEST PV 1540

PEAK POWER MEASURING INSTRUMENT AND CHARACTERISTIC CURVE TRACER FOR PHOTOVOLTAIC SYSTEMS WITH AUTO-RANGING UP TO 1500 V / 40 A

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1 SAFETY INSTRUCTIONS

	Read and follow these instructions carefully and completely in order to ensure safe and proper use. The instructions must be made available to all persons who use the instrument. Keep for future reference.

General

- Observe the five safety rules in accordance with DIN VDE 0105-100, Operation of electrical installations – Part 100: General requirements.
  (1: Shut down entirely. 2: Secure against restart. 3. Assure absence of voltage at all poles. 4: Ground and short circuit. 5. Cover neighboring live components, or make them inaccessible.)
- Observe and comply with all safety regulations which are applicable for your work environment.
- Wear suitable and appropriate personal protective equipment (PPE) whenever working with the instrument.
- The functioning of active medical devices (for example pacemakers, defibrillators) and passive medical devices may be affected by voltages, currents and electromagnetic fields generated by the instrument and the health of their users may be impaired. Implement corresponding protective measures in consultation with the manufacturer of the medical device and your physician. If any potential risk cannot be ruled out, do not use the instrument.

Accessories

- Use only the specified accessories (included in the scope of delivery or listed as options) with the instrument.
- Carefully and completely read and adhere to the product documentation for optional accessories. Retain these documents for future reference.

Handling

- Use the product only for its intended purpose in accordance with this documentation and the documentation for the associated test/measuring instrument.
- The product may only be used by electro-technically trained persons (ETP) and qualified electricians in the commercial field.
- Use the product in undamaged condition only.
  Inspect the product before use. Pay particular attention to damage, interrupted insulation or kinked cables.
  Damaged components must be replaced immediately.
- If the product does not function correctly, discontinue use of the product and dispose of it properly.
- If there are any signs of interior damage to the product (e.g. loose parts in the housing), permanently remove it from operation and secure it against inadvertent use.
- If the product is damaged during use, for example if it's dropped, discontinue use of the product and dispose of it properly.
- Products and accessories from Gossen Metrawatt GmbH are designed to function ideally with products from Gossen Metrawatt GmbH which are specifically intended for this purpose. Unless otherwise expressly confirmed in writing by Gossen Metrawatt GmbH, they are neither intended nor suited for use with other products.
  Exception: Sensors as specified in this document.
- Route cables in an orderly fashion. Loose, disorderly cables result in unnecessary danger of tripping and falling.
- Do not integrate the product into other devices or fixtures.
- Do not touch the product's front panel with sharp or pointed objects.
- Observe applicable safety regulations for work conducted on roofs.

Operating Conditions

- Do not use the product and its accessories after long periods of storage under unfavorable conditions (e.g. humidity, dust or extreme temperature).
- Do not use the product and its accessories after extraordinary stressing due to transport.
- Do not expose the product to direct sunlight.
- Only use the product and its accessories within the limits of the specified technical data and conditions (ambient conditions, IP protection code, measuring category etc.).
- Do not use the product in potentially explosive atmospheres. Danger of explosion!

- Do not use the product in atmospheres subject to fire hazard. Danger of fire!
- Implement adequate measures for protection against electrostatic discharge (ESD).
- Do not expose the instrument to direct contact with water. Do not leave the instrument out in the rain.
- Ensure adequate air circulation and heat dissipation during operation.

Batteries and Rechargeable Batteries

- The corresponding test/measuring instrument may not be used while charging batteries in the test/measuring instrument.
- Please contact our support department if the internal battery no longer delivers sufficient power.

Measurement Cables and Establishing Contact

- Plugging in the measurement cables must not necessitate any undue force.
- Never touch conductive ends (for example of test probes).
- Avoid short circuits due to incorrectly connected measurement cables.
- Ensure that alligator clips, test probes or Kelvin probes make good contact.
- Do not move or remove test probes, alligator clips or Kelvin probes until testing/measurement has been completed. Unwanted sparking may otherwise occur due to test current.
- Maintain adequate distance from current-carrying parts of the cable connection to the PV module.
- Isolate the PV module before connecting or disconnecting the cabling by means of the external safety disconnector.
- Do not connect test connections to ground.
- Connect only a limited DC source (photovoltaic generator) with a maximum of 40 A DC to the instrument.

Data Security

- Always create a backup copy of your measurement/test data.
- The product is equipped with data memory to which personal and/or sensitive data can be stored. Observe and comply with respectively applicable national data protection regulations.

2 APPLICATIONS

Please read this important information!

2.1 INTENDED USE / USE FOR INTENDED PURPOSE

The peak power measuring instrument and characteristic curve tracer PROFITEST PV 1540 is exclusively used for ascertaining the IU characteristic curve of individual photovoltaic modules and strings. Before the device under test is connected to the measuring instrument, it must be assured that the DUT cannot at any time exceed the measuring instrument's maximum permissible current and voltage values.

Safety of the user, as well as that of the instrument, is only assured when it's used for its intended purpose.

2.2 USE FOR OTHER THAN INTENDED PURPOSE

Use of the tester for any purposes other than those described in these operating instructions is contrary to use for intended purpose. Use for other than the intended purpose may lead to unforeseeable damage!

2.3 LIABILITY AND GUARANTEE

The liability and warranty provided by Gossen Metrawatt GmbH are governed by the applicable contractual and mandatory statutory provisions.

3 DOCUMENTATION

3.1 INFORMATION CONCERNING THESE INSTRUCTIONS

Read these instructions carefully and attentively. They contain all necessary information for safe use of the instrument. Comply with them in order to protect yourself and others from injury, and to avoid damaging the instrument.

The latest version of these instructions is available on our website:

https://www.gmc-instruments.de/en/services/download-center/

Errors and Suggestions for Improvement

These instructions have been prepared with utmost care in order to ensure correctness and completeness. Unfortunately, errors can never be entirely avoided. Continuous improvement is part of our quality goal, so we always appreciate your comments and suggestions.

Gender Equality

For better readability, only the masculine form is used in these instructions in a grammatically impartial sense. The feminine and diverse forms are of course always implied as well.

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3.2 IDENTIFICATION OF WARNINGS

Instructions for your safety and for the protection of the instrument and its environment are provided as warnings and notes at certain points within these instructions.

They're laid out as shown below and are graded in terms of the severity of the respective hazard. They also describe the nature and cause of the hazard, the consequences of non-observance and what must be done to avoid it.

DANGER

Death or serious injury is almost certain.

WARNING

Death or serious injury is possible.

CAUTION

Minor or moderate injury is possible.

ATTENTION

Damage to the product or the environment is possible.

Note

Important information

Tip

Useful additional information or application tip

3.3 IDENTIFIERS

The following identifiers are used in this documentation:

Identifier	Meaning
Control element	Keys, buttons, menus and other controls
✓ Prerequisite	A condition etc. which must be fulfilled before a given action can be taken
▶ **Procedure**	Beginning of a procedural instruction
1. Procedural step	Steps of a procedure which must be completed in the specified order
↳ Result	Result of a procedural step
■ Enumeration ■ Enumeration	Bullet lists
Figure 1: Caption	Description of the content of a figure
Tab. 1: Table 1	Description of the content of a table
Footnote	Comment

Table 1: Identifiers in this Document

3.4 ICONS IN THE DOCUMENTATION

The following icons are used in this documentation:

Icon	Meaning
	Read and adhere to the product documentation.
	General warning symbol
	Warning regarding electrical voltage

Table 2: Icons Used in this Document

3.5 FORMULA SYMBOLS

Term	Definition
AM	Air mass, relative length of the path traveled by sunlight through the atmosphere
E	Irradiation intensity
E_0	1000 W/m^2 (irradiation intensity under STC)
E_{RMS}	Momentary effective irradiance with spectral evaluation by the sensor's cell material
FF	Fill factor, ratio $I_{SC} \cdot U_{OC}/I_{pmax} \cdot U_{pmax}$, roughly 0.75 = 75% for crystalline modules, lower values may indicate reduced performance
I	Current
I_m	Abbreviation for I_{pmax}
I_{ph}	Photovoltaic current
I_{pmax}	Current at point of maximum power
I_{pmax0}	I_{pmax} under STC
I_{SC}	Short-circuit current
I_{SC0}	I_{SC} under STC
MPP	Maximum power point, another term for P_{max}
NOCT	Nominal operating cell temperature, cell operating temperature at T_{ambN} = 20 °C where E_N = 800 W/m^2, 1 m^{-1}
P	Power
P_{max}	Instantaneous peak power of a solar cell
P_{pk}	Peak power, nominal peak power of the solar cell under STC, $P_p = I_{SC0} \cdot U_{OC0}$
PV	Photovoltaics, photovoltaic
R	Resistance
R_{pv}	Photovoltaic resistance
R_S	Series resistance, in addition to resistances in the module, e.g. cable/plug resistance, internal resistance of approx. 0.5 Ω for crystalline modules or 2 ... 3 Ω for thin-film cells. Within the string, R_s is influenced significantly by line resistance.
R_p	Internal parallel resistance
R_{pv}	Photovoltaic resistance (only a calculated value, not actual resistance)
STC	Standard test conditions for determining P_{pk}: AM 1.5, T = 25 °C, E0 = 1000 W/m^2
T_{mod}	Module temperature
U	Voltage
U_m	Abbreviation for U_{pmax}
U_{OC}	Open circuit voltage
U_{OC0}	U_{OC} under STC
U_{pmax}	Voltage at point of maximum power
U_{pmax0}	U_{pmax} for STC

Table 3: Formula Symbols

4 GETTING STARTED

This chapter provides an overview of the initial steps for working with the instrument.

1. Read and adhere to the product documentation. In particular, observe all safety information in the documentation, on the instrument and on the packaging.
   - Safety Instructions ➪🗎4
   - Applications ➪🗎6
   - Documentation ➪🗎7
2. Familiarize yourself with the device ➪🗎11.
3. Start up the instrument ➪🗎19.
4. Familiarize yourself with the display and instrument operation.
   - Operation➪🗎19
   - Software PV Analyzer ➪🗎29.
5. Configuration and Operation.
   - Operation➪🗎19
   - Software PV Analyzer ➪🗎29.

Further topics of interest: Maintenance ➪🗎44

5 THE INSTRUMENT

5.1 SCOPE OF DELIVERY

Please check the scope of delivery for completeness and intactness.

1 PROFITEST PV 1540 peak power measuring instrument
1 Shielded mini USB cable for connection to a PC
1 External power pack, 60 W
1 Irradiation reference sensor
1 External Pt100 temperature sensor for temperature at the back of the module or at the jumper plug
1 External safety disconnector between the 4-wire power measurement cable and the PROFITEST PV 1540
1 4-wire measurement cable, 10 m
1 Accessories case
1 PV analyzer software*
1 Test report
1 Calibration Certificate

* Available for download ⇨ "Downloading the Software" 🗎29

5.2 OPTIONAL ACCESSORIES

Some measurements necessitate optional accessories:

Z360H SUNCLIX-MC4 PV Adapter Set
Solar connector cable, length: 300 mm, cross-section: 4 mm^2

5.3 INSTRUMENT OVERVIEW

5.3.1 TOP VIEW



Abb. 1: Top View

1	On / off switch **(power)**
2	Display
3	USB port to PC
4	Socket for external power supply, 60 W
5	Status lamps **external power supply** and **charge level**
6	Irradiation input or combined irradiation and temperature input
7	Pt100 or Pt1000 temperature measurement input
8	4-wire measurement input for voltage measurement
9	4-wire measurement input, voltage measurement

5.3.2 DISPLAY ELEMENTS AND CONTROLS

Graphic User Interface Elements, PROFITEST PV 1540

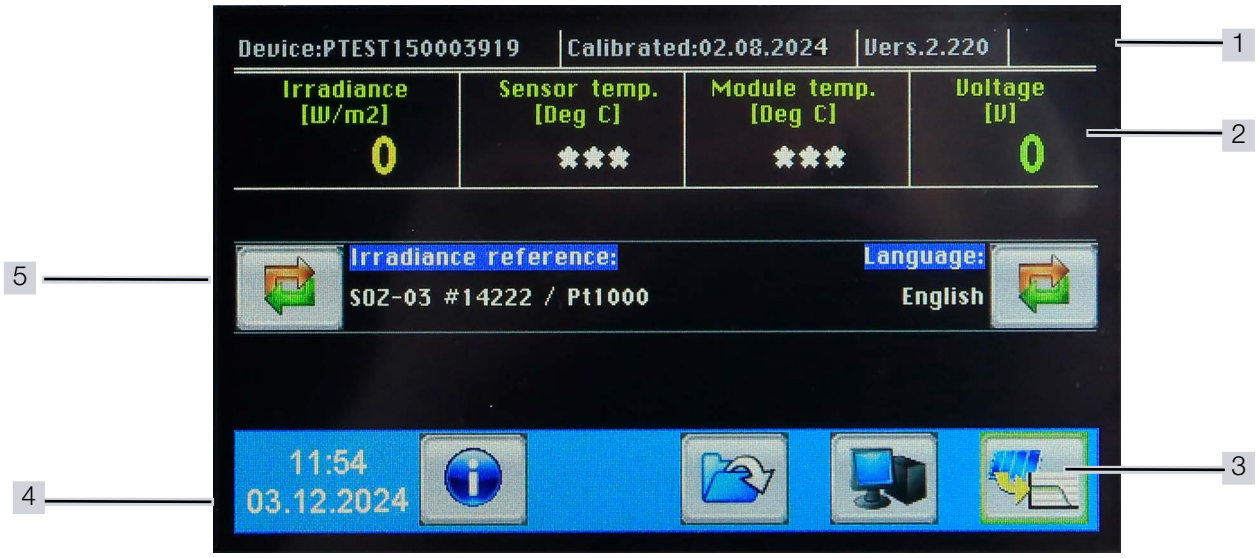


Abb. 2: Graphic User Interface Elements on the PROFITEST PV 1540 (main menu)

1 Header
Instrument serial number, calibration date, firmware version

2 Sensor row
The currently active irradiation reference sensor is displayed here and can be changed if necessary.

3 Buttons

4 Footer
Current date and time

5 Data row
Instantaneous irradiation, temperature of the irradiation reference sensor, temperature at the back of the module (optional), voltage applied to the power input

Buttons

Button	Designation	Function
	**Information**	Displays an overview of the buttons
	**Switch**	Switches to an entry
	**New measurement**	Opens the submenu
	**Archive**	Loads a measurement from the archive
	**PC**	Establishes a connection to the PC and activates transfer
	**Start**	Starts a curve tracing measurement
	**Abort**	Aborts a function/action
	**List**	Displays the results list

Button	Designation	Function
	**Diagram**	Displays the characteristic I-U curve
	**Add**	Adds an entry
	**Back**	Scrolls back one page
	**Forward**	Scrolls forward one page
	**OK**	Confirms a selection
	**Delete**	Deletes a data record

Table 4: Buttons on the Graphic User Interface of the PROFITEST PV 1540

Status Lamps

The “Charge Level” status lamp indicates the charge level of the internal battery.

“Charge Level” LED	Meaning
Red	External power supply not connected: The battery charge level is low. The instrument cannot be used. Charge battery immediately.
	External power supply connected: The battery is being charged. The charging cycle has not yet been completed.
Yellow	The battery is fully charged. The instrument is ready for use.
Alternating yellow and green	The battery charge level is being maintained in the trickle charge mode. This charging process can be continued for approximately 1 to 3 hours. Longer charging in this mode is not advisable because the battery might otherwise be damaged.
Green	External power supply not connected: The battery is ready for use. The instrument is ready for use.
	External power supply connected: The battery is being charged. Charging is essentially complete – trickle charge. The instrument is ready for use.
Off	External power supply connected: Charging has been fully completed.

Table 5: Status Lamp States

The “Charge Level” lamp lights up when the external power pack is connected and switched on. The internal battery is charged automatically.

Acoustic Signals

Various system functions and errors are indicated by acoustic signals.

x = low-pitched tone

– = high-pitched tone

Signal	When	Meaning
Click	When the membrane keypad is pressed	Simulates the click of a keyboard.
–	During operation	Indicates the beginning or the end of a function.
x	In the event of an error	Observe information provided by the instrument regarding errors.
–	When the main menu first appears	The instrument is ready for operation.
x or x x	Shortly after switching on	Processor OK
x or x x followed by x x	Shortly after switching on	The processor's lithium backup battery is depleted. Customer service required.
– – x x		The display is not responding. Switch the instrument off, wait briefly and then switch it back on again. If the same error occurs again: Customer service required.
– –	After transferring a file to the PROFITEST PV 1540 (service only)	File transfer OK
x – x	After transferring a file to the PROFITEST PV 1540 (service only)	File transfer not OK Target file is deleted.
– – – –	During a measurement	Irradiation fluctuates or is inadequate. The measurement is inaccurate and must be discarded.
– – – x x x – – –		The A/D converter could not be initialized. Customer service required.

Table 6: Acoustic Signals

5.3.3 SYMBOLS ON THE INSTRUMENT AND THE INCLUDED ACCESSORIES

Symbol	Meaning
	Warning concerning a point of danger (attention, observe documentation!)
	Double insulation (protection category II)
	European conformity marking
	The instrument may not be disposed of with household trash ⇨ "Disposal and Environmental Protection" 🗎48.
	Warning regarding dangerous electrical voltage

Table 7: Symbols on the Instrument and the Included Accessories

5.4 INCLUDED FEATURES

The PROFITEST PV 1540 is a portable measuring instrument in a rugged housing powered by an integrated rechargeable battery. The instrument is equipped with its own miniature industrial PC and a high-contrast, color graphic LCD which can be read clearly in daylight. The PROFITEST PV 1540 is operated by means of a touchscreen and an on-screen menu. If required, a PC can be connected via a USB port in order to transfer data and analyze measured values.

The PROFITEST PV 1540 facilitates the measurement of characteristic I-U curves of photovoltaic modules and strings. The PROFITEST PV 1540 enables the performance of measurements under prevailing environmental conditions and conversion to STC by the measuring instrument. And thus a single measurement of the characteristic curve provides immediate results including peak power P_{pk}, internal series resistance R_S and parallel resistance R_p. Measurement results appear at the display.

All standard irradiation sensors that generate a voltage of approximately 0 to 100 mV, which demonstrates a linear relationship to irradiation, can be connected to the instrument (Phox sensor). Minimum irradiation required for conversion is 500 W/m^2.

Depending on the instrument variant, an additional Pt100 sensor can also be connected. This makes it possible to measure the temperature of the module, and is mounted on the back of the module.

- Sampling rate: max. 100 kHz
- Resolution: 0.01 V … 0.25 V, 0.005 A … 0.001 A (depending on selected measuring range)
- Measuring accuracy: better than 1% (as of 10 W)
- Peak power ascertainment tolerance: ±5%
- Reproducibility of peak power results: ±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.
- The irradiation reference sensor (Phox) with integrated Pt100 or Pt1000 sensor measures irradiation and cell temperature.
- The 4-wire power measurement cable to the PV module prevents systematic voltage measuring errors.
- Irradiation reference sensor (Phox) with integrated Pt100/Pt1000 temperature sensor
- Supplementary measurement of temperature at the back of the module is possible (a second Pt100 input is provided).
- Connection is only permissible to direct voltage sources with current limiting (e.g. photovoltaic modules).

The PROFITEST PV 1540 automatically measures the characteristic current-voltage curve of the PV module at a capacitive load, as well as the momentary temperature and irradiation at the time of measurement, and calculates the effective characteristic solar cell curve, P_{pk}, R_p and R_S from the captured data. After measurement has been concluded, the measurement data are automatically stored to a memory module with long-term battery backup and can be retrieved later on. The instrument can store data up to 1000 measurements to internal memory.

Up to 50 module types can be exported to the PROFITEST PV 1540.

The following values are displayed as results:

- Absolute values:
  - Peak power P_{Pk}
  - Series resistance R_S
  - Internal parallel resistance (shunt resistor) R_p
- Instantaneous values:
  - U_{pmax}, I_{pmax}, P_{max},
  - U_{oc}, I_{sc}, FF, T_{mod}, E_{trms}

The acquired characteristic I-U curve can also be shown directly at the display if desired.

5.5 RELEVANT STANDARDS

The instrument has been manufactured and tested in accordance with the following safety regulations:

DIN EN 60529 IEC 60529	Test instruments and test procedures Degrees of protection provided by enclosures (IP code)
DIN EN 61010-1 IEC 61010-1	Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements
DIN EN 61326-1 IEC 61326-1	Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements
DIN EN 61326-2-1 IEC 61326-2-1	Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 2-1: Particular requirements – Test configurations, operational conditions and performance criteria for sensitive test and measurement equipment for EMC unprotected applications

Regulations and standards for use of the instrument:

DIN EN 62446-1 IEC 62446-1	Photovoltaic (PV) systems – Requirements for testing, documentation and maintenance Part 1: Grid connected systems – Documentation, commissioning tests and inspection

Table 8: Relevant Standards

5.6 TECHNICAL DATA

Power Supply	Rechargeable lithium-ion battery:	11.25 V 8850 mAh 99.6 Wh Continuous operation: approx. 8 hr. Power consumption: approx. 40 W
	External power pack:	In 90 … 263 V_{AC} 47 … 63 Hz 60 W
Ambient Conditions	Operating temperature:	0 … +50 °C
	Storage temperature:	-10 … +85 °C
	Relative atmospheric humidity:	Max. 90%, no condensation allowed
	Elevation:	Max. 2000 m
Electrical Safety	Measuring category:	Cat III 1500 V_{DC}, max. 1500 V_{DC} between the inputs
	Pollution degree:	2
	Protection category:	II
Electromagnetic Compatibility (EMC)	Interference emission:	Conducted emission: EN 55011, group 1, class B EN 55032, class B
		Field strength: EN 55011, group 1, class A EN 55032, class BA
	Interference immunity:	EN 55011 EN55032 EN61326-1 EN61326-2-2 EN 61000-3-2 EN 61000-3-3 EN 61000-4-2 EN 61000-4-3 EN 61000-4-4 EN 61000-4-5 EN 61000-4-6 EN 61000-4-11
Mechanical Design	Protection:	Housing: IP67 per DIN EN 60529 / IEC 60529 (protection against ingress of solid foreign objects: dust-proof; protection against water ingress: protected when immersed)
	Housing (W × H × D):	Approx. 410 × 328 ×175 mm
	Weight:	Approx. 9.5 kg
	Display:	Color LCD LED backlight Resolution: 480 × 272 pixels Suitable for use in sunlight
Data Interfaces	USB:	USB mini-B socket, USB 2.0
Internal Memory	Flash memory in the instrument:	Space for 1000 measurements 50 module types can be exported to the PROFITEST PV 1540.
Computer Section	Miniature industrial PC:	A/D sampling rate: max. 100 kHz Resolution: 12-bit Measuring accuracy for characteristic I-U curve better than 1% Peak power: ±5%

Table 9: Technical Data

5.7 CHARACTERISTIC VALUES

Measuring Range	Voltage [V]	Current [A]	Temperature [°C]	Irradiation
PROFITEST PV 1540	25, 100, 500, 1500	2, 5, 10, 40	-40 °C … +120 °C with Pt1000	0 … 1300 W/m^2 (standard sensor)

Table 10: Characteristic Values

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

Sensor Connection Pin Allocations

Temperature (external): 4 pin female chassis socket, Lumberg KFV40

- 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 KFV81 (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) –

6 OPERATION

6.1 POWER SUPPLY

The PROFITEST PV 1540 is equipped with a rechargeable battery including an integrated charging controller, as well as overcharge and deep-discharge protection. The instrument can thus be used independent of mains power. The charge level is indicated by an LED on the front panel.

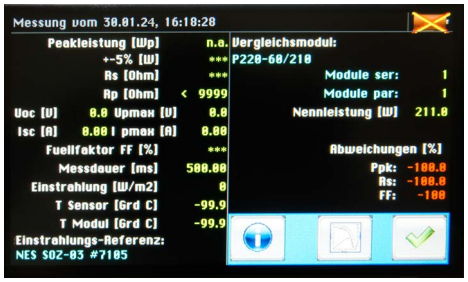
6.2 CHARGING THE BATTERY

1. Connect the external power pack for the PROFITEST PV 1540 to the external power supply socket on the front panel.
   ↳ The battery is charged.
2. To interrupt charging, remove the power pack plug from the socket on the PROFITEST PV 1540.

6.3 SWITCHING THE INSTRUMENT ON

1. Press the **Power** key.
   ↳ The initial screen appears.
   ↳ The instrument executes several self-tests. This process takes about 10 to 15 seconds.
   ↳ The main menu appears.

↳ The instrument is ready for operation.



6.4 CONNECTING PERIPHERAL DEVICES

The measuring setup consists of the peak power measuring instrument and the following additional components:



Figure 3: Measuring Setup

1	External Pt100 for temperature at the back of the module or at the jumper plug	4	Irradiation reference sensor
2	External safety disconnector between the 4-wire power measurement cable and the PROFITEST PV 1540	5	External power pack, 60 W
3	4-wire measurement cable	6	USB connection to PC (optional)

The PROFITEST PV 1540 is equipped with the following inputs and outputs. The interfaces are located on the front of the instrument. The connection for the external power pack is located on the back of the instrument.

Interface	Function
Mains	External power pack: connection via barrel plug, 5.5 x 2.1 mm
Temperature	Connection for temperature sensor ■ Instruments with 2 measuring inputs: external Pt100 for acquiring temperature at the back of the module ■ Other instruments: external Pt100 for measuring temperature at the back of the reference cell
Irradiation	Connection for irradiation reference sensor (Phox) – The reference sensor's Pt100/Pt1000 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 to the PC via USB cable

Table 11: Interfaces

6.5 ISOLATING THE PV MODULE

An external safety disconnector between the 4-wire power measurement cable and the PROFITEST PV 1540 disconnects the PROFITEST PV 1540 from PV generator voltage when work is carried out on the cabling.



DANGER

Electric Shock

During measurement and in the event of electrical damage, high DC currents occur. If the plug connection is interrupted, an electric arc may occur between the plug and the socket, causing serious or fatal injury.

- Isolate the PV module before connecting or disconnecting the cabling by means of the external safety disconnector (set to **0** position).
- Insert the plugs of the 4-wire power measurement cable into the sockets as far as they will go.
- Never interrupt a plug connection during measurement.
- If you discover any defects on the switch, the housing, the connector cables or the sockets, do not actuate the safety disconnector any more.
- Defective safety disconnectors may only be repaired by specially trained technicians authorized by the manufacturer.
- Keep the safety disconnector and the connecting cables away from liquids, dust and dirt.

1. Before connecting any cables, switch the safety disconnector to its neutral position, i.e. **0**. Both **0** positions are the same.
2. Insert the measurement cables with MC plugs included with the PROFITEST PV 1540 into the switch sockets as far as they will go.
   Insert red plugs into red sockets and black plugs into black sockets. Each of the two red and black plugs are the same. The arrangement of plugs of the same color is not important.
3. Connect the cables attached to the switch to the PROFITEST PV 1540.
   Insert red plugs into red sockets and black plugs into black sockets. Each of the two red and black plugs are the same. The arrangement of plugs of the same color is not important.

↳ The PV module is isolated.

6.6 CONNECTING THE PV MODULE



DANGER

Electric Shock

During measurement and in the event of electrical damage, high DC currents occur. If the plug connection is interrupted, an electric arc may occur between the plug and the socket, causing serious or fatal injury.

- Isolate the PV module before connecting or disconnecting the cabling by means of the external safety disconnector (set to 0 position).
- Insert the plugs of the 4-wire power measurement cable into the sockets as far as they will go.
- Never interrupt a plug connection during measurement.
- Maintain adequate distance from current-carrying parts of the cable connection to the PV module.

ATTENTION

Damage to the Instrument due to High Voltage

The instrument short circuits the PV module during characteristic curve tracing. The instrument may be damaged or destroyed due to a battery connected in parallel or a charging capacitor in the input of an inverter.

- Before measuring, disconnect the PV module under test from all consumers, batteries and inverters.

ATTENTION

Damage to the Instrument due to High Voltage

Connecting PV modules with excessively high direct currents can destroy the instrument.

- Connect only limited DC power sources with a maximum of 40 A DC to the instrument's power measurement input.

✓ The safety disconnector is connected to the PROFITEST PV 1540 and is set to the 0 position.

1. Connect the measuring instrument to the PV module – ensuring correct polarity – using the adequately dimensioned, included connector cables. The plus pole is red and the minus pole is black.
2. Make sure that all of the power cable plugs are inserted into the sockets on the housing as far as they will go.
3. Use the two sockets on the right side of the housing for the PV module (four-wire measurement input, current measurement). In the event of reversed polarity, the reverse polarity protection diode in the PROFITEST PV 1540 prevents short-circuiting of the PV module.



Note

Voltage measurement is not possible unless the 4-wire measurement inputs at the PROFITEST PV 1540 are fully connected. If measurement will be performed with only two measurement cables, jumper the sockets of one color on the PROFITEST PV 1540 with the neighboring sockets of the same color using jumper plugs, lab cables or the like.

6.7 CONNECTING THE SENSORS

ATTENTION

Property Damage!

The use of unsuitable irradiation sensors or incorrect sensor settings may result in damage to the device or the sensor.

- When using third-party sensors, observe information provided in the respective technical data and characteristic values (e.g. pin assignments etc.). Corresponding sensor data are available from the respective manufacturers.
- Gossen Metrawatt GmbH recommends using the included sensor.

Temperature and irradiation reference sensors are not required for internal series resistance measurements or pure characteristic curve tracings.

1. For peak power measurements, connect a Pt100/Pt1000 temperature sensor (depending on model) and a Phox irradiation reference sensor to the sockets provided for this purpose at the PROFITEST PV 1540.
   The sockets are laid out such that it's not possible to plug the temperature sensor or the irradiation reference sensor into the wrong socket. Use the combination irradiation/temperature sensor included as standard equipment with the PROFITEST PV 1540.
2. Mount the combination irradiation/temperature sensor as close as possible to the modules under test.
   Observe the following in this regard:
   - The sensor is aligned to the sun in the same way as the modules under test (compass direction and angle of inclination).
   - There are no bright surfaces within close range, e.g. buildings that could distort the incidence of light.
3. Use a clamp to attach the sensor to the module under test in such a way that it doesn't cast a shadow on the module.
4. Wait several minutes for the sensor to adjust to ambient temperature.
   In the case of instruments without a second temperature measurement input, the irradiation reference cell must reach a temperature which approximates that of the module under test.

Tip

The temperatures can be read from the display at the PROFITEST PV 1540 when it's switched on.

We recommend checking the temperature at the back of the device under test manually as well, for example with an infrared thermometer.

6.8 ENTERING MODULE, CUSTOMER AND SYSTEM DATA

Module, customer and system data can be entered before starting a measurement. Measured values obtained during measurement can then be saved directly as customer data.

The following parameters are available:

Parameter	Meaning
Modules ser	Number of modules connected in series.
Modules par	Number of strings/modules connected in parallel.
Customer	Entry/selection of customers in the database Customer data is entered either to PV Analyzer software or directly to the PROFITEST PV 1540 test instrument (max. 30 characters).
System	Entry/selection of system parameters
String/module	Entry/selection of installation parameters
Module type	Entry/selection of module types and parameters

Entering the Number of Modules

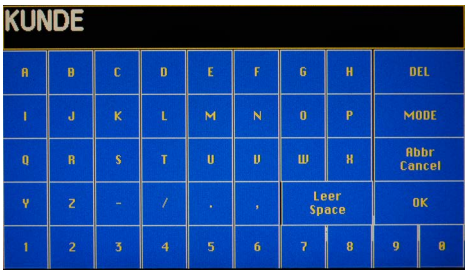
1. Select the **Modules ser** field.
2. Enter the number of modules connected in series.
3. Select the **Modules par** field.
4. Acknowledge your entry with **OK**.
5. Enter the number of strings/modules connected in parallel.
6. Acknowledge your entry with **OK**.



Editing Customer Data

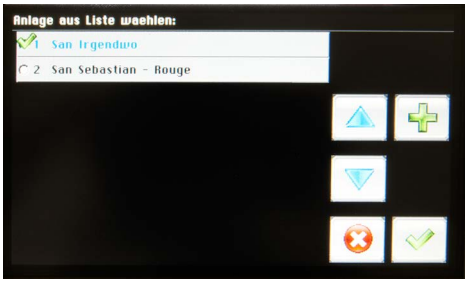
1. Select the **Customer** field.
2. Select an existing customer from the list.
3. Make the desired entries.
4. Acknowledge your entry with **OK**.
5. To add a new customer, tap **Add**.
6. Make the desired entries (max. 30 characters).
7. Acknowledge your entry with **OK**.





Editing System Data

1. Select the **System** field.
2. Select an existing system from the list.
3. Make the desired entries.
4. Acknowledge your entry with **OK**.
5. To add a new system, tap **Add**.
6. Make the desired entries (max. 30 characters).
7. Acknowledge your entry with **OK**.





Editing Installation Parameters

1. Select the **String/Module** field.
2. Select an existing entry from the list.
3. Make the desired entries.
4. Acknowledge your entry with **OK**.
5. To add a new entry, tap **Add**.
6. Make the desired entries (max. 30 characters).
7. Acknowledge your entry with **OK**.



Editing the Module Type

1. Select the **Module Type** field.
2. Select an existing entry from the list.
   The database in the PV Analyzer contains 1000 entries. Up to 50 module types can be exported to the PROFITEST PV 1540.
3. Make the desired entries.
4. Acknowledge your entry with **OK**.
5. To add a new entry, tap **Add**.
6. Make the desired entries. The module's characteristic values are required to this end.
7. Acknowledge your entry with **OK**.



6.9 STARTING A MEASUREMENT

DANGER

Electric Shock

During measurement and in the event of electrical damage, high DC currents occur. If the plug connection is interrupted, an electric arc may occur between the plug and the socket, causing serious or fatal injury.

- Never interrupt a plug connection during measurement.
- Maintain adequate distance from current-carrying parts of the cable connection to the PV module.

Note

In order to achieve good measurement accuracy, solar radiation at the time of measurement should be at least 500 W/m^2 if possible. Characteristic curve tracing is also possible at lower values, but results for peak power are then inaccurate, for which reason they're not displayed.

✓ Peripheral devices and necessary sensors are connected to the PROFITEST PV 1540.
✓ The safety disconnector is connected to the PROFITEST PV 1540 and is set to the **0** position.
✓ The PV module is connected to the PROFITEST PV 1540.
✓ Measuring conditions have been complied with (see Kapitel "Influences on Measuring Accuracy" ➪🗎26).

1. Set the safety disconnector to the **1** position. Both **1** positions are the same.
2. Tap the **Start** button.
   ↳ Characteristic curve tracing is executed. This process takes 1 to 2 seconds.
   ↳ The measurement results are calculated and appear at the display.
   ↳ Any possible messages appear at the display as well.

↳ The measurement has been completed.

6.10 DISCONNECTING THE CABLES FROM THE PV MODULE

DANGER

Electric Shock

During measurement and in the event of electrical damage, high DC currents occur. If the plug connection is interrupted, an electric arc may occur between the plug and the socket, causing serious or fatal injury.

- Isolate the PV module before connecting or disconnecting the cabling by means of the external safety disconnector (set to **0** position).

✓ The measurement has been completed.

1. Set the safety disconnector to the **0** position.
2. Remove the cables from the PROFITEST PV 1540.

6.11 EVALUATING THE MEASUREMENT

The measurement results are calculated and appear in the results page.

1. Tap the **Diagram** button.
   ↳ The characteristic I-U curve is displayed.
2. Tap the **List** button.
   ↳ The results page is displayed with the calculated data (peak power, R_S, R_p, FF) and measured values (voltages and currents).

After the measurement, any possible messages appear at the display.

Message	Meaning
Fluctuating irradiation (ref. cell)!	Irradiation on the reference cell or module is not constant enough (e.g. due to passing clouds). Measurement results may be inaccurate.
Too little irradiation!	
Fluctuating irradiation (mod.)!	
Not available	The measured value could not be calculated.
No space for new data!	Internal permanent memory at the PROFITEST PV 1540 is full. Delete data from the PROFITEST PV 1540 before starting any new measurements.
Write error	Problems encountered while writing a measurement data series to internal permanent memory.
Measurement not yet possible	Safety waiting time between two measurements has not yet elapsed.
Rs calculation not possible	The measurement data do not support the calculation of R_S.
Measured values cannot be evaluated	The measured values include data that make it impossible to evaluate the characteristic curve, e.g. the shape of the I-U characteristic curve deviates significantly from the standard characteristic curve.
Input voltage too high	The measuring instrument can be damaged by excessive voltage. Immediately disconnect the PV module via the load disconnector!
Immediate repair required	The instrument is damaged and must be inspected and, if necessary, repaired by authorized service personnel. The instrument may not be used again until it has been examined by the manufacturer. 1. Set the safety disconnector to the **0** position. 2. Immediately disconnect the instrument from the device under test.
Incorrect polarity!!	The cables at the PROFITEST PV 1540 are connected incorrectly. 1. Immediately disconnect the PV module via the load disconnector. 2. Connect the cables correctly.

Table 12: Messages

6.12 RETRIEVING MEASUREMENTS FROM THE ARCHIVE

1. Select the **Archive** field.
2. Select an existing measurement series from the archive.
   Existing measurement series are listed in the order in which they were created.
3. Tap the **Up** or **Down** button to navigate up or down through the list.
4. Tap the **Next** or **Previous** button to view additional pages if desired.
5. Tap **OK** to open a selected file.
6. Tap **Delete** to remove a data record from memory.
   This operation cannot be undone!
7. Tap **Cancel** to return to the previous page.

6.13 FURTHER INFORMATION ON MEASUREMENTS

6.13.1 INFLUENCES ON MEASURING ACCURACY

Make sure that the module under test is not shaded. Even minimal shadows, for example cast by blades of grass, can cause measurable error. The same applies to the reference sensor. Contamination of the modules has the same effect as shading. Higher levels of irradiation on the module result in more accurate measurement results.

If possible, irradiation (ascertained by the combination sensor) on the module should be greater than 500 W/m^2.

The combination irradiation/temperature sensor measures temperature at the back of the reference cell. If the PROFITEST PV 1540 only receives a temperature value from the irradiation reference sensor because no external temperature sensor has been mounted in order to measure temperature at the back of the module, the PROFITEST PV 1540 assumes that the temperature of the reference cell and that of the module under test are roughly the same. This is indeed the case to an adequate degree of accuracy if the reference cell and the PV modules have been exposed to the same amount of irradiation for a long enough period of time. For this reason, the module and the cell should be aligned to the sun identically for more than 15 minutes before measurement is performed. However, to be on the safe side, temperature at the back of the module should be measured before curve tracing in this case, e.g. with an infrared thermometer.

If possible, the module to be measured should be aligned perpendicular to the sun's rays. However, this is frequently not possible. Sufficient irradiation at the surface of the module is important in this case (which automatically necessitates orientation toward the sun to at least a given extent), as is precise alignment of the reference cell: it must have exactly the same orientation as the module. In the simplest of all cases, the combination sensor is simply clamped to the module under test. However, the combination sensor may be located some distance from the module if it can be assured that alignment to the sun is really identical and that no reflections in the surroundings can influence the irradiation measurement values. The reference must face the same part of the sky as the device under test.

In principle, the irradiation reference must also have the same spectral properties as the DUT (in accordance with IEC 60904) – in other words, it should ideally have the same structure. It's entirely possible to use a module which is identical in design to the module under test as a reference: the module is subjected to a load via a precision shunt resistor, and measurable voltage occurring at the shunt as a result is used as a measure of momentary irradiation – this is exactly how most reference sensors work.

If alignment of the reference cell deviates even a few degrees from that of the PV module, considerable error may occur in the measurement results. Maximum accuracy can be assured for the measurement if several measurements (e.g. 5) are performed on the same object and the results are evaluated statistically.

Accuracy of Peak Power Calculations from Characteristic I-U Curve Traces from PV Modules

Under the following conditions, the peak power specifications of the PROFITEST PV 1540 demonstrate an accuracy of ± 5% relative to the actual peak power value of the device under test.

- The device under test consists of monocrystalline or polycrystalline silicon cells.
- The device under test is not shaded, not even minimally.
- The irradiation reference sensor is not shaded, not even minimally.
- Essentially, the irradiation reference sensor must demonstrate the same spectral sensitivity as the device under test.
- Measurement is performed in natural sunlight.
- In accordance with IEC 60904, the sun should be oriented vertically within a tolerance of ± 10° to the active surface of the device under test.
- Irradiation should amount to at least 800 W/m^2 in accordance with IEC 60904. Based on our own comparative measurements, we consider an irradiation value of 600 W/m^2 sufficient.
- Irradiation measurement must be performed immediately before or after I-U curve tracing, and elapsed time between curve tracing and irradiation measurement must be less than 10 ms.
- The measured value from the irradiation reference sensor must be corrected on the basis of measured cell temperature
- Cell temperature measurement must take place immediately before or after curve tracing within 1 second with an accuracy tolerance of 1 K.
- The active surface of the device under test must lie within the same plane as the surface of the irradiation reference sensor with an accuracy tolerance of ± 5%.
- Irradiation prior to I-U curve tracing must constant enough (±10 W/m^2) for a period of at least 10 seconds, in order to avoid misinterpretation of DUT and reference cell temperature.
- During I-U curve tracing, irradiation may not fluctuate by more than 10 W/m^2 (the PROFITEST PV 1540 generates a warning in this case).
- The temperatures of the device under test and the irradiation reference sensor must be settled in – no further temperature changes may be displayed.
- Voltage and current from the device under test are measured with separate measurement cables (4-wire measurement).

6.13.2 CAUSES OF REDUCED OUTPUT AND YIELD

Error	Cause	Remedy
System is not ideally configured	Measurement of mismatch losses	Planning errors ■ Reconfiguration
Incorrect adaptation of strings to inverter	Power supplied to the grid too low for the location and not enough power from the PV module	Planning errors ■ Reconfiguration Replace the inverters
Shaded by cast shadows	Characteristic I-U curve has “bumps”, too little peak power, visual inspection	Obstacle in direct proximity to the module (e.g. bird droppings) ■ Remove obstacle
Diffuse shading (possibly undetectable with the naked eye!)	Characteristic I-U curve is “dented”, too little peak power	Obstruction at some distance (high diffuse-light component) ■ Remove obstacle
Corrosion on plugs/terminals	Internal series resistance Rs too high	Material defect, planning and/or assembly errors ■ Clean, replace
Peeling of the cell embedding	Same as “diffuse shading”	Material or manufacturing defect ■ Replace
Formation of bubbles in the resin	Same as “diffuse shading”	Material defect ■ Replacement by supplier
Cover material becomes opaque (glass, plastic, resin)	Visual inspection, peak power too low (see also “diffuse shading”)	Material defect ■ Replacement by supplier
Discoloring of the transparent cover material (plastic, resin)	Visual inspection, peak power too low (see also “diffuse shading”)	Material defect ■ Replacement by supplier
Penetration by moisture between the laminate – leads to further damage (corrosion, discoloring)	Visual inspection	Material or manufacturing defect ■ Replacement by supplier
Defects in the crystalline structure of individual cells (hot-spot effect)	Same as “diffuse shading”	Manufacturing defects ■ Price reduction, replacement by supplier
Module contaminated with dust	Visual inspection, same as “diffuse shading”	Exposure to excessive dust (usually not a problem in Germany) ■ Inspection/cleaning at regular intervals
Moss and algae growth on the module, bird droppings	Same as “shaded by cast shadows”	Normal depending on region and location ■ Cleaning
Broken cover glass – leads to further damage (corrosion, discoloring)	Visual inspection	Hail damage, assembly errors, transport damage ■ Replacement by supplier
Broken individual cells in the module	Too little peak power, characteristic I-U curve may be distorted	Material defect ■ Replacement by supplier
Poor electrical connections inside the module	Too little peak power, internal series resistance R_S higher than calculated	Soldering defects, material defects, corrosion ■ Replacement by supplier
Defective bypass diode (short-circuit)	Peak power of the string reduced by an amount equal to module power	Overloading, material defects ■ Repair
Bypass diode installed in the wrong direction	Peak power of the string reduced by an amount equal to module power	Assembly errors ■ Repair

Error	Cause	Remedy
No bypass diode or defective bypass diode (high impedance)	Shading of just one module may dramatically reduce the power of the entire string	Planning and/or assembly errors ■ Repair
Cabling under-dimensioned	Internal series resistance R_S too high	Planning errors ■ Replace cabling
Defective cable (e.g. broken, corrosion)	Internal series resistance R_S too high	Assembly errors ■ Repair
Plug connectors incorrectly connected	Internal series resistance R_S too high	Assembly errors ■ Repair
Corrosion in screw or plug connectors	Internal series resistance R_S too high	Assembly errors ■ Cleaning, repair
Incorrect pre-selection of modules based on peak power (good/bad modules in one string)	Too little peak power from the overall system	Planning and/or assembly errors (mismatch loss) ■ Rearrangement of modules after peak performance measurement
Incorrect pre-selection of individual cells based on power during module manufacturing	Too little peak power from the module	Manufacturing defects ■ Price reduction, replacement by supplier
Short-circuit between individual cells in the module	Too little peak power from the overall system, open-circuit voltage Uoc to low, characteristic curve	Manufacturing defects ■ Replacement by supplier
Manufacturing tolerances in cell production	Too little peak power, characteristic curve	Manufacturing defects ■ Price reduction, replacement by supplier
Please note: Errors may only become apparent under certain operating conditions, e.g. high module temperatures. This list makes no claims with regard to completeness or accuracy.		

Table 13: Causes of Reduced Output and Yield

7 PV ANALYZER SOFTWARE

Note

"PV Analyzer" is a software program from PV-Engineering GmbH.

Please contact PV-Engineering GmbH if you have any questions or problems with the software.

Gossen Metrawatt GmbH only provides support for use of the program in combination with the PROFITEST PV 1540.

Use of the PROFITEST PV 1540 does not require a PC. However, if extended data evaluation or external control is desired, the PROFITEST PV 1540 can be connected to a PC. Measurements can be started and data can be managed with the help of PV Analyzer software.

Observe the terms and conditions for use by the end user of Gossen Metrawatt GmbH software.

7.1 SYSTEM REQUIREMENTS

- PC
- Operating system: Windows® 10 or Windows® 11
- Mouse as pointing device for control
- USB port for connecting the PROFITEST PV 1540 to the PC
- Approximately 52 MB of free space on the hard disk

7.2 ACTIVATING TRANSFER

1. Tap the **PC** button in order to activate transfer.
   ↳ The PROFITEST PV 1540 is prepared for control via the connected PC.
2. Tap any button at the PROFITEST PV 1540 in order to end transfer.

7.3 CONNECTING A PC

1. Connect one end of the included USB cable to a free USB port at the PC.
2. Connect the other end of the included USB cable to the **PC** port at the PROFITEST PV 1540.

7.4 DOWNLOADING THE SOFTWARE

1. Open your personal **myGMC** account (German website only):
   https://www.gossenmetrawatt.de/service-support/mygmc/
2. Create a **myGMC** account.
3. Log in to your personal **myGMC** account.
4. Register your instrument in the personal area of **myGMC**.
   ↳ A download link for "PV Analyzer" software is made available in the personal area of **myGMC**.
5. Download the software (**profitest-pv-analyzer.zip**).

7.5 INSTALLING THE SOFTWARE

1. Unzip the downloaded file.
2. Run the installation file.
3. Follow the instructions provided by the installation program on your PC.
   ↳ Setup is executed. PV Analyzer is installed to your PC.

Tip

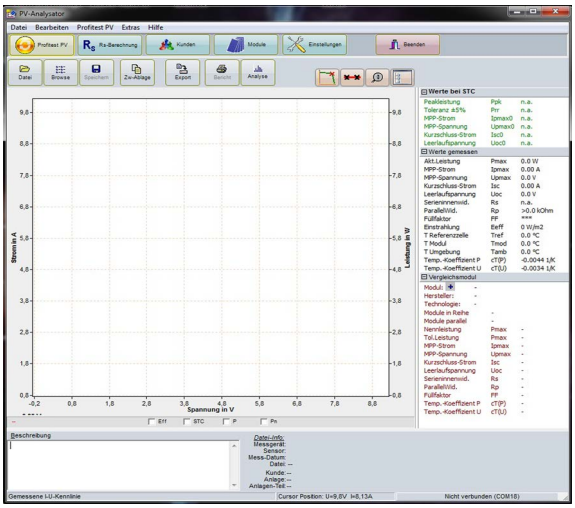
The program creates files with the **.sui** extension, which contain measurement data from an I-U measurement. After these measurement files have been automatically transferred from the PROFITEST PV 1540, the file names include the date and time of the measurement in order to identify the data records.

Example: The file with the name **24-05-24 14_17_04.sui** contains data from a measurement taken on 24 May 2024 at 2:17:04 p.m.

The measurement files are usually saved to folders in the following directory path: “documents\PV-Analysator\”.

7.6 STARTING THE SOFTWARE

1. Launch the “PV Analyzer” program.
   ↳ The initial screen appears.



The document shown in the example is empty and all displayed values are zero. You can access measurement data stored on the hard disk, perform a measurement or import measurement data from the PROFITEST PV 1540. Acquired measured values are stored in this document. You can evaluate these measured values or save them to a file.

The following displays are available for evaluation:

- Measured values line diagram
- Right column with results
- **Export** function for creating a file with measured values or results in a format other than the default format

Grayed out buttons are disabled. They can only be used when data is actually available.

7.7 GRAPHIC USER INTERFACE

7.7.1 CONTROLS

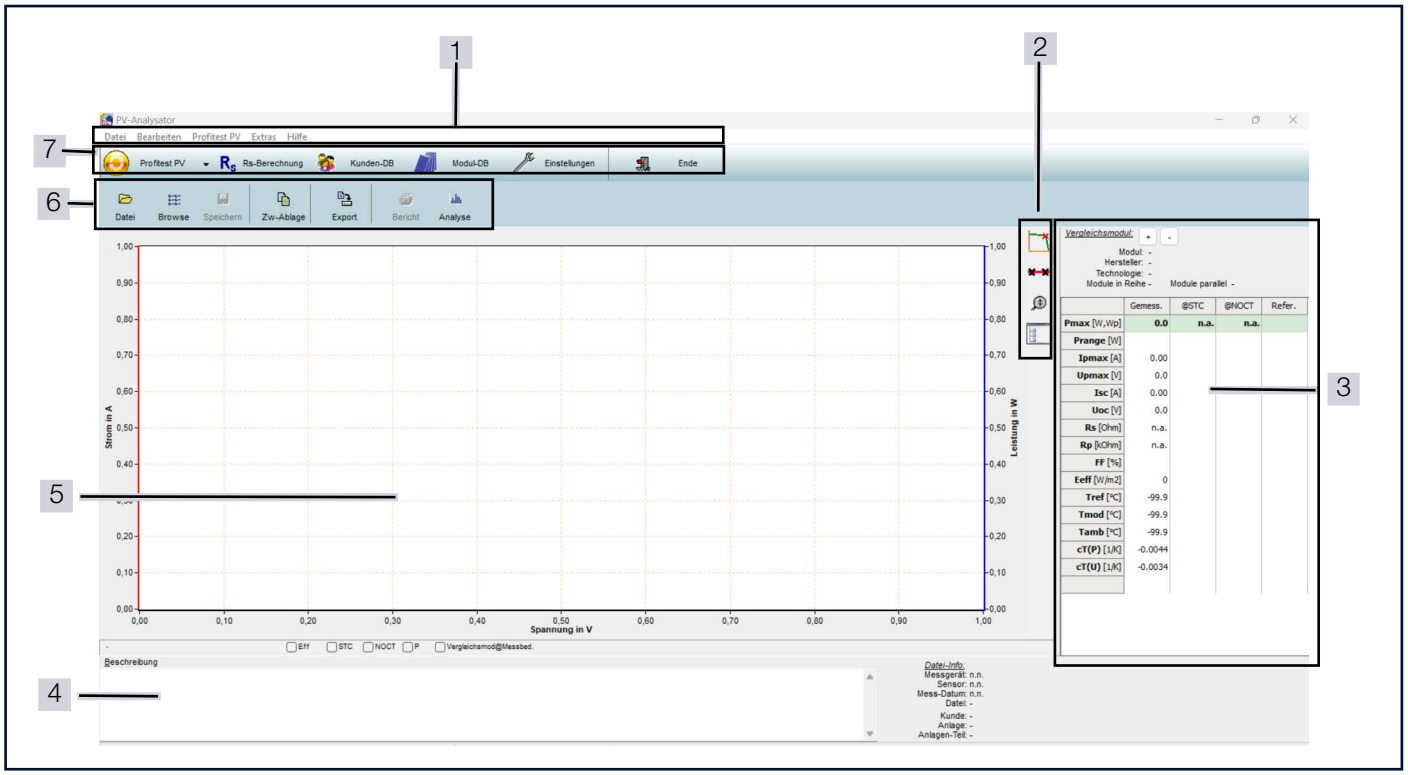


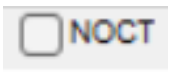
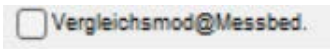
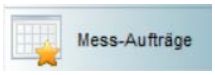
Abb. 4: Graphic User Interface Elements for PV Analyzer

1	Menu bar	5	Comment field
2	Display controls for measurement graphics	6	Toolbar
3	Measured value display fields	7	Tab
4	Measurement graphic		

7.7.2 PV ANALYZER DISPLAY ELEMENTS AND CONTROLS

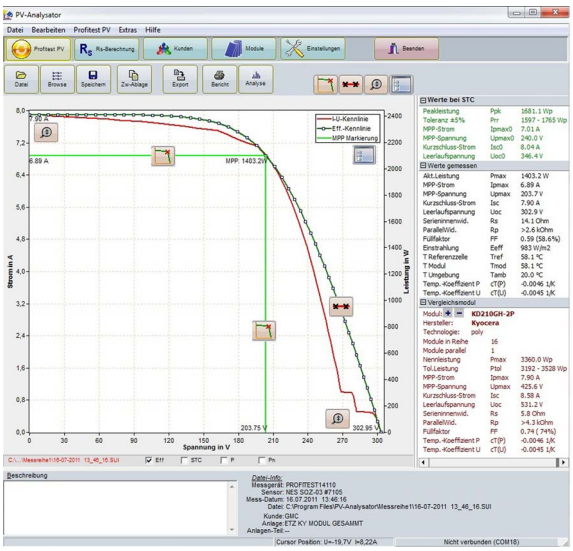
PV Analyzer Buttons

Button	Designation	Function
	**File**	Opens a file.
	**Browse**	Shows minimized curves from the data files in the selected directory.
	**Save**	Saves the momentary characteristic curve.
	**Clipboard**	Copies the current graphic to the Windows clipboard. From there, it can be inserted into other applications such as Microsoft® Word.
	**Export**	Exports measurement data to a different file format.
	**Report**	Opens a measurement report for the active data record.
	**Analysis**	Evaluates the characteristic curve measurement.

Button	Designation	Function
	**Measuring points**	Switches the display of measuring points in the measured characteristic curve on or off.
	**Show MPP**	Switches the display of a calculated MPP (maximum power point) on or off. The MPP is not taken directly from the measurement data table, and is instead interpolated.
	**Key**	Switches the key for the diagram on or off. The key is displayed in the upper right-hand portion of the graphics window.
	**Max. zoom**	Scales the graphic so that it takes up as much space as possible in the graphic display.
	**Display theoretical curve**	Switches the characteristic RMS curve on or off. If possible, a theoretical characteristic curve approximation is then generated and this curve is displayed as well.
	**Display characteristic STC curve**	Switches the characteristic STC curve on or off. If possible, the characteristic curve converted to STC conditions is then also displayed. The scale range is automatically enlarged if applicable.
	**Display theoretical curve**	Displays a theoretical curve.
	**Display characteristic power curve**	Switches the characteristic P-U curve on or off. In addition to the characteristic I-U curve, the characteristic P-U curve can also be displayed here. The right-hand scale serves as a reference axis for power.
	**Display comparator module under measuring conditions**	Enables or disables information from a comparator module under measuring conditions.
	**Get Data**	Starts data transfer to the PROFITEST PV 1540. The **Transfer** function must be activated at the PROFITEST PV 1540 to this end.
	**Trace characteristic curves**	Starts a characteristic curve trace.
	**Continuous measurement**	Opens the **Continuous Measurement** option.
	**Sensor list**	Opens the sensor database.
	**Module list**	Opens the **Manage Modules** option.
	**Measuring jobs**	Opens the **Manage Measuring Jobs** option.

Tab. 14: Buttons on the Graphic User Interface of PV Analyzer

Graphics Window



After loading a measurement or performing a new measurement, the graphic can be accessed by clicking the **graphic** button (if it's not already displayed).

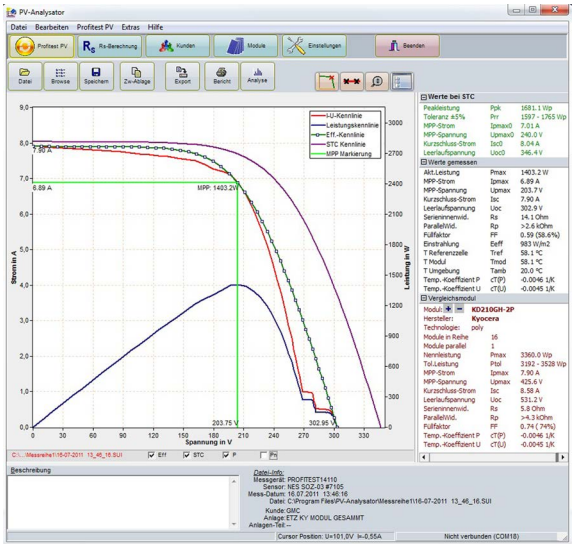
A rectangle can be drawn in the graphics window by pressing and holding the left mouse button while moving the mouse from the top left to the bottom right. The selected area is then enlarged at the display. The normal view can be restored by drawing a rectangle from the bottom right to the top left. Right click the graphics window and keep the button pressed in order to move the graphics window.

A pop-up menu appears after right-clicking the graphic. The following options are then made available:

- **Measuring points**
- **Show MPP**
- **Key**
- **Max. zoom**

These functions can also be accessed using the buttons above the graphics window.

Results



Measured values, values converted to standard test conditions (STC) and the values for the module to be compared are displayed next to the characteristic curve.

7.8 MENU BAR

The following functions can be accessed via the menu bar:

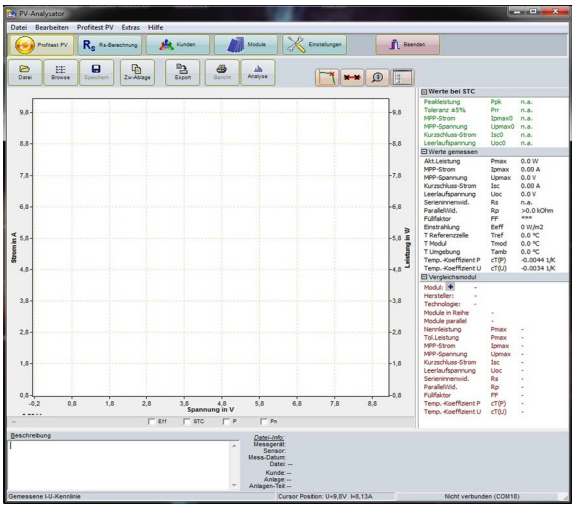
Menu	Submenu/Option	Function
File	**Open**	Opens a file.
	Save as	Saves the momentary characteristic curve.
	Browse	Shows minimized curves from the data files in the selected directory.
	Export	Exports measurement data to a different file format.
	Printer setup	Opens the Windows printer setup dialog, where the desired printer can be set up.
	Print	Prints the selected file.
	Exit program	Closes the program.
Edit	**Cut**	Deletes the marked text and inserts it into the clipboard.
	Copy	Copies the marked text to the clipboard.
	Paste	Inserts the contents of the clipboard into the selected text.
Profitest PV	**Start measurement at Profitest PV**	Starts a characteristic curve trace.
	Manage files at Profitest PV	Makes it possible to manage the files.
	Transfer date/time to Profitest PV	Transfers date and time from the PC to the PROFITEST PV 1540.
	Edit Profitest PV sensor database	Opens the sensor database.
	Continuous measurement	Sets up automatic, PC-controlled measurement with the PROFITEST PV 1540.
Extras	**Edit customer database**	Opens the customer database.
	Edit module database	Opens the module database.
	Calculate series resistance RS	Determines expected internal series resistance RS from STC reference values for short-circuit current, open-circuit voltage and current and voltage values at the MPP.
	Settings	Changes the serial interface, the working directory, temperature offset or the dialog language.
Help	**Content**	Function not currently available.
	Search	Function not currently available.
	Internet search for updates	Searches the internet for available updates.
	Register file association for .sui	Registers the .sui file association.
	Info	Displays the program's current revision level.

7.9 TOOLBAR

7.9.1 FILE

- **File** Button

Accesses the submenus or options for managing files.



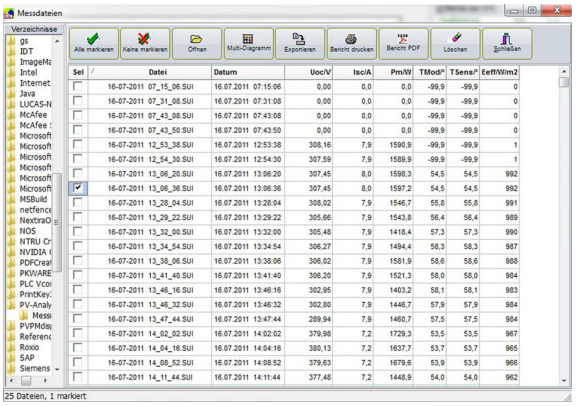
- **Open** Button

Opens previously traced and stored characteristic curves.

The most recently processed data in main memory is overwritten as a result of this action. If you want to keep these data, they have to be saved before opening another document. These files use the .sui extension by default.

After clicking the directory symbol next to the directory displayed at the top of the dialog window, the directory whose measurement data should then be displayed in the list can be specified in the following dialog.

Any entry in this list can be double-clicked. The respective data are then loaded automatically and displayed in the editing window. Several or all of the entries on the list can be selected, after which the selected data records can be deleted or exported, or the test reports can be printed by clicking the corresponding button.



7.9.2 CLIPBOARD

Copies the current graphic to the Windows clipboard. From there, it can be inserted into other applications such as Microsoft® Word.

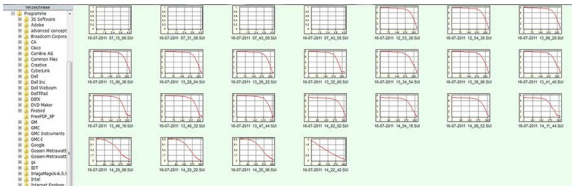
7.9.3 BROWSE

Shows minimized curves from the data files in the selected directory.

This provides a quick overview of recorded measurements, making it easy to identify any unusual characteristic curves.

The most important measurement results can be displayed in a small information window by pointing at a graphic with the cursor.

Double-clicking on a graphic opens the file.

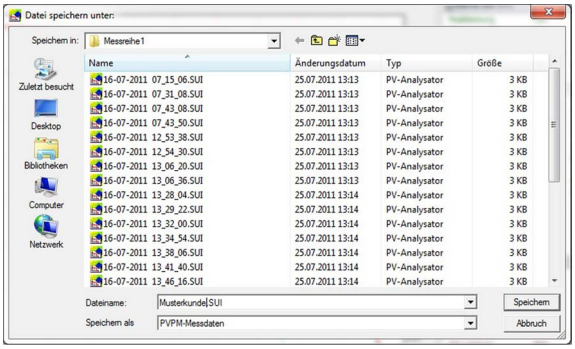


7.9.4 SAVE

Saves the momentary characteristic curve to a data storage medium. Any plain text entries in the **Description** field are saved as well.

The program supports long file names.

The default extension is “.sui”.



7.9.5 EXPORT

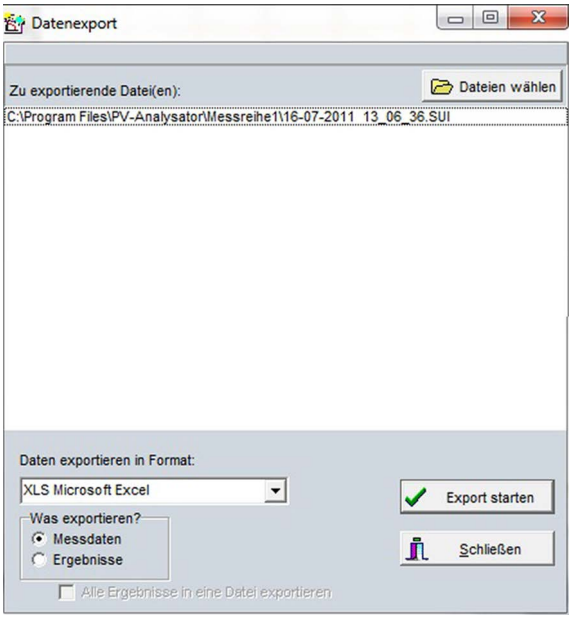
Exports and converts files containing measurement data from the PROFITEST PV 1540 into a format that can be read by other programs.

.xls (Microsoft® Excel) and .dbs (dBase III+) formats can be used, as well as three different ASCII representations. Refer to the user manual for the respective program for information on how to select the correct format to be used for processing the measured values.

Either pure measurement data (I-U measurement points, temperature and irradiation) or calculation results can be exported. Calculation results from several measurements can be exported together to a table. Data are displayed line by line in the target table.

Select the desired export format from the drop-down list. The files to be exported are selected in the file selection dialog box which appears after clicking the **Select Files** button. Click **OK** after the files have been selected.

The export files are then created and saved to the same directory with the same file name, but with a different file extension (for example .xls instead of .sui). The exported files can then be processed in a program of your choice. Any changes made to the exported files do not affect the original data.

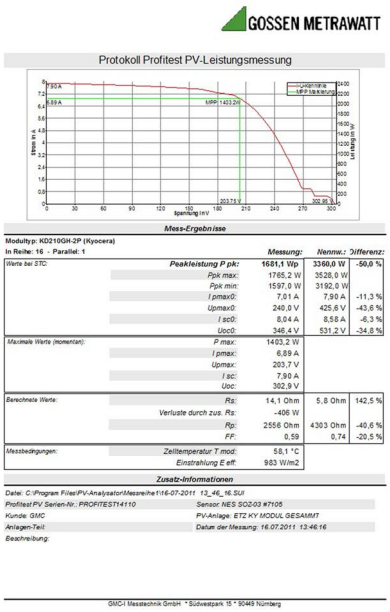


7.9.6 REPORT

Opens a measurement report for the active data record.

The report can be printed out or written to a PDF file.

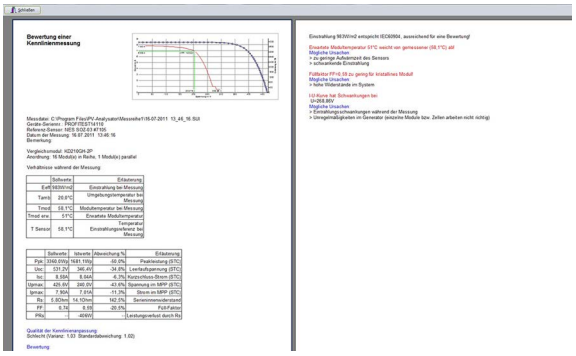
Please note that under certain circumstances it may be necessary to change your printer’s page orientation before printing. The printout uses all available paper space.



7.9.7 ANALYSIS

Conducts an analysis.

The analysis serves to evaluate the characteristic curve trace. All relevant data are arranged in tabular form. Possible causes of any errors are outlined briefly in an overview.



7.10 PROFITEST PV TAB

7.10.1 GET DATA

✓ The PROFITEST PV 1540 is connected and the **Transfer** function is activated at the PROFITEST PV 1540.

Transfers data from the PROFITEST PV 1540 to the PC and manages data from the PROFITEST PV 1540 at the PC.

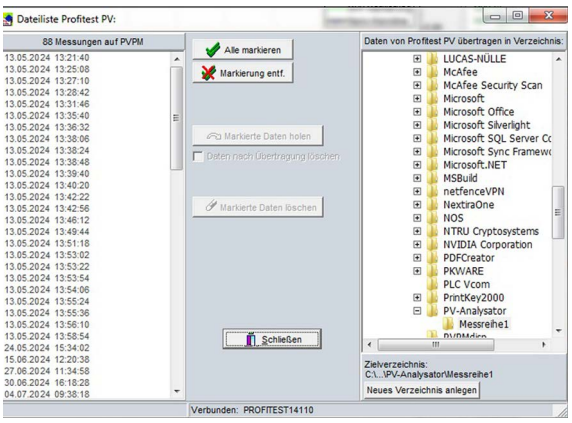
Clock time at the PC and the PROFITEST PV 1540 is first of all compared. If the time difference is greater than five minutes, the application asks whether time at the PROFITEST PV 1540 should be set to PC time.

After the time check has been completed, a corresponding message or the list of measurement series appears if data memory at the PROFITEST PV 1540 is empty. The displayed files can then be transferred to the PC.

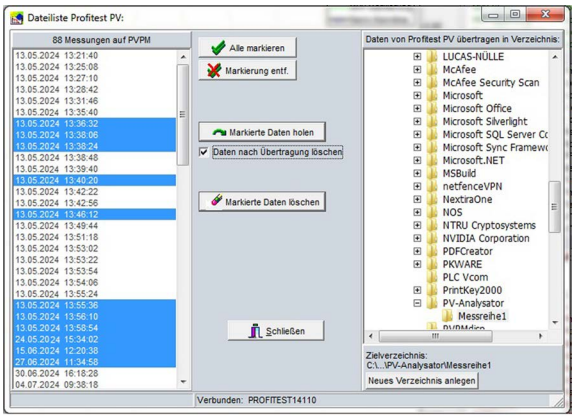
Select the target directory to which the measurement data will be transferred in the line displayed at the top of the window. Click the directory icon at the right side of the line to this end. A directory selection dialog appears in which the target directory can be selected.

Select one, several or all measurements in the measurement series list and click **Get Data**.

The series are then transferred one after the other. Each data record is saved to the PC hard disk using a file name with the following format: “04-01-2024 10_44_38.sui” (in this example a measurement performed on 4 January 2024 at 44 minutes and 38 seconds after 10 a.m.).



If the **Delete Data After Transfer** checkbox is activated, a dialog box appears after the measurement data has been transferred asking whether the measurement data from the PROFITEST PV 1540 should be discarded. If you’re certain that the data at the PROFITEST PV 1540 s no longer needed, answer with **Yes**. The selected measurement series are then deleted automatically from the PROFITEST PV 1540. Data can also be deleted from the PROFITEST PV 1540 by selecting the file to be deleted in the list and clicking **Delete Data**.



Note

Deleted data cannot be restored.

7.10.2 TRACING CHARACTERISTIC CURVES

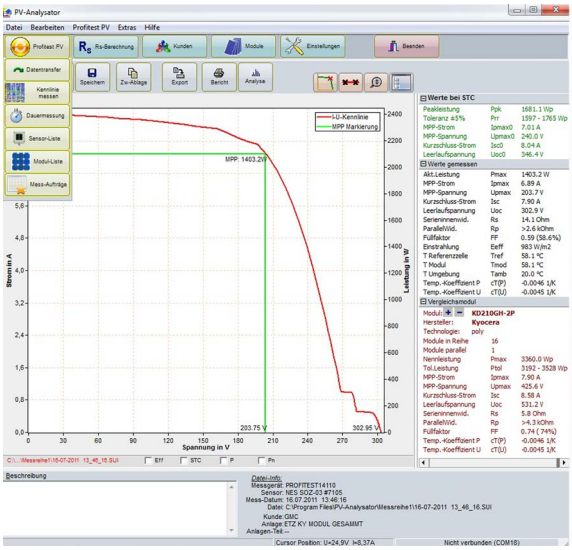
✓ The PROFITEST PV 1540 is connected and the **Transfer** function is activated at the PROFITEST PV 1540.

Start a characteristic curve trace at the PROFITEST PV 1540.

Click the **Trace Characteristic Curves** button. The following message appears in the status bar: "**Measurement in progress – please wait.**" Measurement takes about 2 seconds. The measured values are transmitted immediately after measurement has been completed. Process progress is displayed in the status bar. The main window with measurement values appears.

The data can be displayed in a diagram or as a tabular overview, and exported or saved to a file. In this case, the characteristic curve data are not saved to the PROFITEST PV 1540, but rather only to the PC. This is advantageous if you want to perform lengthy measurement runs with large amounts of measurement data. Storage space at PROFITEST PV 1540 might otherwise be exhausted at some point.

If an error message appears, the cable to the PROFITEST PV 1540 is not correctly connected or the **Transfer** function has not been activated at the measuring instrument.



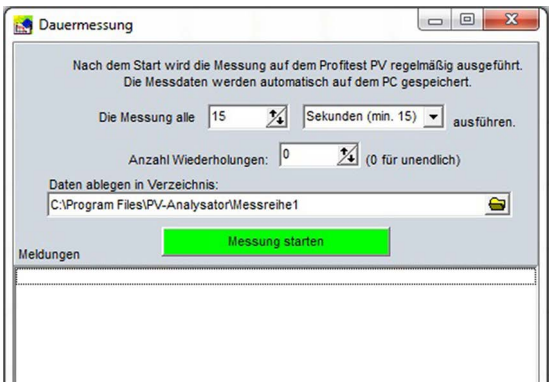


7.10.3 CONTINUOUS MEASUREMENT

Performs automatic measurements with the PROFITEST PV 1540, which are scheduled and controlled by the PC.

Set the time interval and unit of measure (seconds, minutes, hours) at which the measurement should be repeated, as well as the number of repetitions. Set to 0 if measurements will be repeated endlessly.

After activating the **Start Trace** button, measurement is performed automatically and can be ended by clicking **Stop**. The measurement data are saved automatically to files in the specified directory and the date and time of measurement are included in the file name.



Automatic measurement is terminated when the desired number of measurements has been performed or in the event of technical problems (PROFITEST PV 1540 doesn't respond).



7.10.4 SENSOR LIST

✓ The PROFITEST PV 1540 is connected and the **Transfer** function is activated at the PROFITEST PV 1540.

Manages the sensor database in the PROFITEST PV 1540.

ATTENTION

Property Damage!

The use of unsuitable irradiation sensors or incorrect sensor settings may result in damage to the device or the sensor.

- Gossen Metrawatt GmbH recommends using the included sensor.
  Gossen Metrawatt GmbH assumes no liability and provides no support in the event that other sensors are used.
- When using third-party sensors, observe information provided in the respective technical data and characteristic values (e.g. pin assignments etc.).

Irradiation sensors from various manufacturers can be connected to the PROFITEST PV 1540. Gossen Metrawatt GmbH recommends using the included sensor.

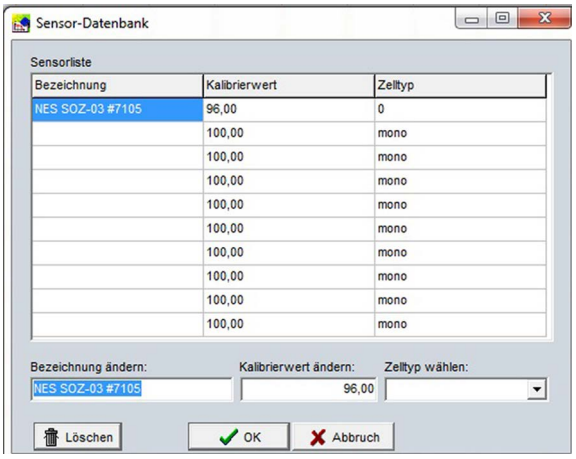
Due to the fact that calibration values vary from sensor to sensor, the calibration value must be adjusted at the measuring instrument to match the utilized sensor. In order to facilitate this procedure on site, the PROFITEST PV 1540 supports a database of up to 10 sensors, whose designation and calibration values can be entered and/or changed. Corresponding sensor data are available from the respective manufacturers.

If the sensor is changed, the desired sensor data can be selected in the **Profitest PV** menu at the PROFITEST PV 1540.

The current database is loaded from the PROFITEST PV 1540 when the **Sensor List** function is accessed.

In order to make a new entry, select an empty field in the list with the cursor and enter the designation and the calibration value in the entry fields below the list.

Click **OK** after completing your entry. You are then asked whether the changed data should be transferred to the PROFITEST PV 1540. Answer with **Yes**. The new data are then immediately available at the PROFITEST PV 1540.

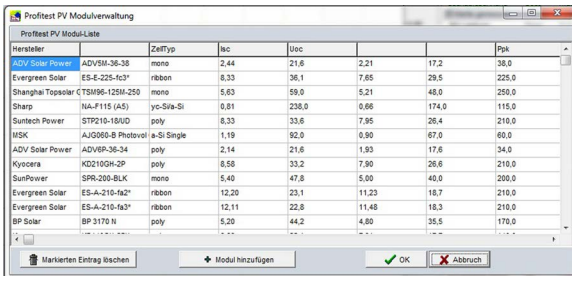


7.10.5 MODULE LIST

Manages the modules in the PROFITEST PV 1540.

A module database for up to 50 modules is included in the PROFITEST PV 1540. This can be freely configured via the software's module database.

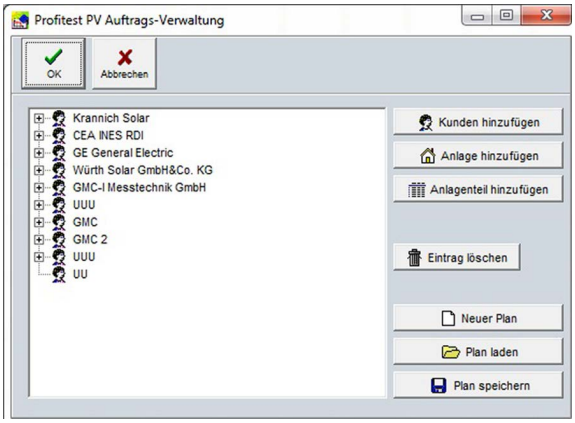
Modules can be added (**Add Module**) or deleted (**Delete Selected Entry**).



7.10.6 MEASURING JOBS

Manages measuring jobs at the PROFITEST PV 1540.

The customer database is accessed directly. Customers, systems, system components and plans can be edited.

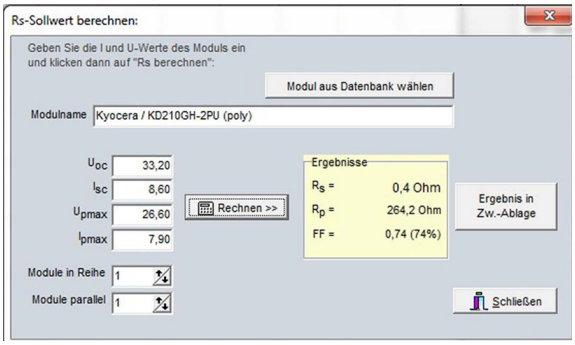


7.11 R_S CALCULATION TAB

Calculates internal series resistance R_S.

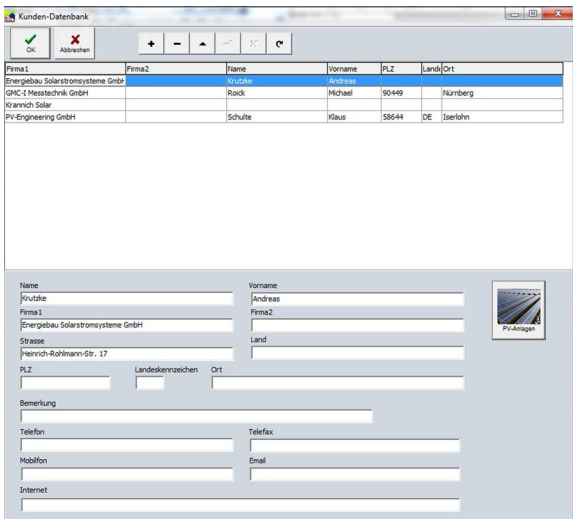
Select the module to be compared from the database in order to calculate.

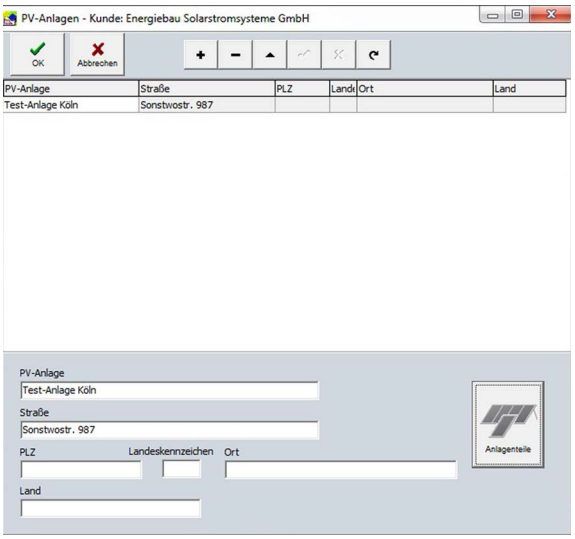
The PROFITEST PV 1540 can calculate the characteristic RMS solar cell curve from the STC reference values for short-circuit current, open-circuit voltage and the current and voltage values at the MPP, from which it can also determine expected internal series resistance R_S. This theoretical value can then be used for comparison with a value obtained from a trace: if the measured value is higher than the theoretical value, the difference is due to resistance in the cabling.



7.12 CUSTOMER DB TAB

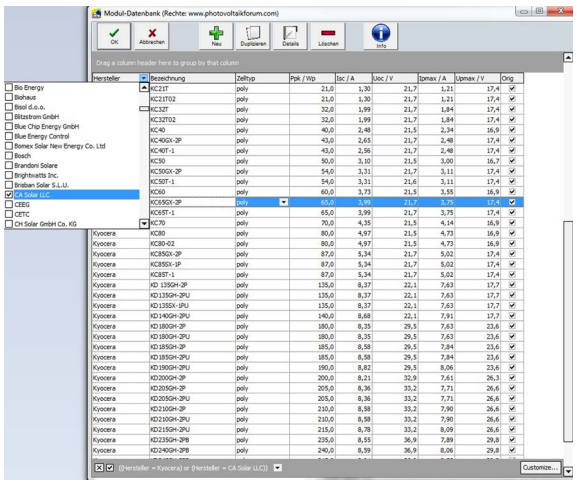
Manages all relevant customer data, system data and system components.

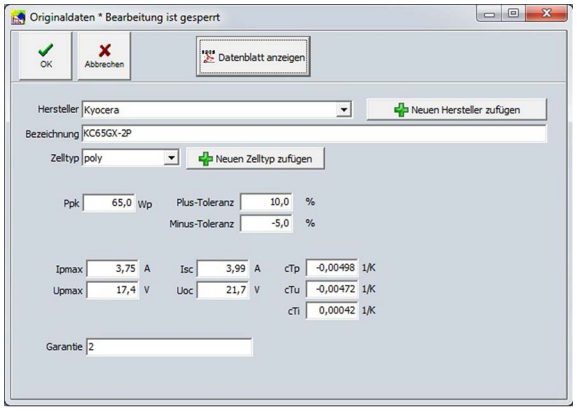




7.13 MODULE DB TAB

The module database is based on the database of the Photovoltaic Forum. All of the characteristic values required for comparison are included. Current data sheets are available from the PV module manufacturers. Characteristic values can be entered manually at any time.





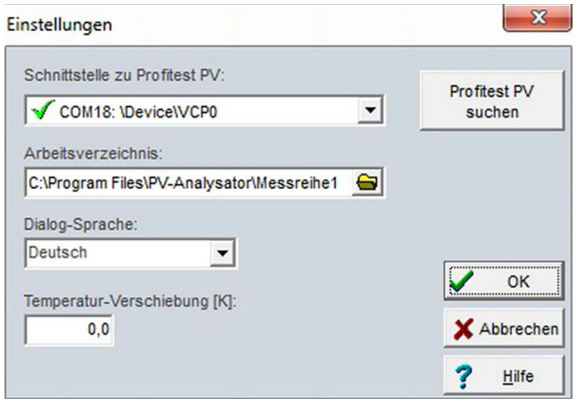
7.14 SETTINGS TAB

Accesses the submenus or options for individual settings.

Any changes made here are automatically saved and retain validity until changed again.

7.14.1 SELECTING THE SERIAL INTERFACE

✓ The PROFITEST PV 1540 is connected and the **Transfer** function is activated at the PROFITEST PV 1540.



Sets the PC interface (COMn:) used for communication with the PROFITEST PV 1540.

Select the interface from the drop-down list. If the application is able to read the interfaces from the Windows registry, the names of all detected interfaces are displayed in the drop-down list, along with indication as to whether or not each interface is available. If not, the respective interface is already occupied by another application.

If the registry cannot be read (insufficient authorization) the application will only display the generic interface names, i.e. “COMn”. Selection of the interface is also possible in this case.

If you don’t know which interface the PROFITEST PV 1540 is connected to, click the **Search** button. The application then attempts to establish connection with the PROFITEST PV 1540 via all available interfaces.

If the application receives a response from a PROFITEST PV 1540, the search is terminated and the identified interface is used for communication with the PROFITEST PV 1540.

7.14.2 SELECTING THE WORKING DIRECTORY

The contents of the working directory are displayed by default in the Open File and Save dialogs. Enter the directory to which you will normally save your data. This directory is also used for automatic data storage (data transfer from the PROFITEST PV 1540 or continuous measurement). A directory selection window can be opened with the button at the right in the input field, from which a directory can be selected.

7.14.3 CHANGING THE DIALOG LANGUAGE

The current edition of PV Analyzer supports German and English as dialog languages. The language can be changed while the program is running. Select the desired language from the **Dialog Language** drop-down list. The language is changed after the dialog box has been closed.

7.14.4 SETTING TEMPERATURE OFFSET

If there's a known temperature difference between the temperature measured at the sensor and the actual temperature at the back of the module (possible, for example, with in-roof systems), a correction factor can be entered here to adjust the measured temperature. The entered value is added to the measured temperature, i.e. if a negative value is entered, the measured temperature is decreased. Calculations performed by PV Analysator then use the adjusted value. However, this value is not saved with the file!

7.15 END TAB

Exits the PV Analyzer program.

Current data are not saved automatically, but you're informed that data still needs to be saved and are offered the opportunity of saving your data before the program is closed.

Deactivate transfer at the PROFITEST PV 1540 when PV Analyzer is closed.

Always exit the PROFITEST PV 1540 with the **Exit** function, the **END** button or the **<ALT>-<F4>** key combination and return to the system. It's important to shut down the system properly after exiting, because data might otherwise be lost.

8 STORAGE AND TRANSPORT

ATTENTION

Improper Storage

Damage to the product and measuring error due to environmental influences.

- Store the instrument in a protected location and only within the limits of permissible ambient conditions. The respective ambient conditions (temperature, humidity etc.) can be found under ⇨ "Technical Data" 🗎17.

ATTENTION

Improper Transport

Damage to the product and measuring error.

- Transport the instrument only within the limits of permissible ambient conditions (temperature, humidity etc.) ⇨ "Technical Data" 🗎17.

9 MAINTENANCE

9.1 CLEANING



DANGER

Life Endangering due to Electric Shock!

The instrument and its accessories are operated with electrical power, thus resulting in a general risk of electric shock. This can be fatal or cause serious injuries.

- The instrument, the accessories and all connected conductors must be voltage-free before and during cleaning. Switch the test instrument off and disconnect it from mains power.
- Never immerse the instrument/accessories in water or other fluids.
- Never touch the instrument/accessories with wet or moist hands.

ATTENTION

Unsuitable Cleaning Agents

Unsuitable cleaning agents such as aggressive or abrasive cleansers result in damage to the instrument/ accessories.

- Use a cloth for cleaning, which has been slightly dampened with water.
- Avoid the use of cleansers, abrasives or solvents.

Keep the outside surfaces of the device and any accessories clean.

9.2 CALIBRATION

Use of your device and resultant stressing influence the device and lead to deviation from warranted accuracy values.

In the case of strict measuring accuracy requirements, as well as in the event of severe stressing (severe climatic or mechanical stress), we recommend a relatively short calibration interval of two years. If this is not the case, a calibration interval of 3 years is usually adequate.

Please contact GMC-I Service GmbH for calibration services ⇨ "Contact, Support and Service" 🗎46.

A sticker with an instrument-specific guideline value for the calibration interval and information regarding the service provider is included on the instrument as an aid.



Note

Date on Calibration Certificate / Calibration Interval Begins Upon Receipt

Your instrument is furnished with a calibration certificate on which a date appears. This date may be further in the past if your instrument has been stored for some time prior to sale.

The instruments are stored in accordance with the specified conditions. Drift is thus negligible for a duration of 1 year and longer storage periods are highly unusual.

Consequently, the instrument's characteristic values lie within the specifications and the first calibration interval can be determined as of the date of receipt.

10 REPAIR

If your instrument requires repair, please contact our service department ⇨ "Contact, Support and Service" 🗎46.

Note

Loss of warranty and guarantee claims

Unauthorized modification of the instrument is prohibited. This also includes opening the instrument.

If it can be ascertained that the tester has been opened by unauthorized personnel, no guarantee claims can be honored by the manufacturer with regard to personal safety, measuring accuracy, compliance with applicable safety measures or any consequential damages.

If the guarantee seal is damaged or removed, all guarantee claims are rendered null and void.

- The device may only be repaired or opened by authorized, qualified personnel who are familiar with the associated dangers.
- Original replacement parts may only be installed by authorized, qualified personnel.
- The instrument may not be placed back into operation until troubleshooting and repair have been performed, and calibration and dielectric strength have been tested and approved at our factory or by an authorized service center.

Note

Data Protection

Data can be stored in the instrument. This may include personal and/or sensitive data.

Back up your data before sending the instrument for repair.

Also, be aware of the owner's or end user's own responsibility with regard to protecting personal and other potentially sensitive data in the instrument before sending it for repair.

11 CONTACT, SUPPORT AND SERVICE

Gossen Metrawatt GmbH can be contacted directly and conveniently – we have a single number for everything! Whether you require support or training, or have an individual inquiry, we can answer all of your questions here:

+49 911 8602-0	Monday to Thursday:	08:00 am - 4:00 pm
	Friday:	08:00 am - 2:00 PM
Or contact us by e-mail at:	info@gossenmetrawatt.com	

Do you prefer support by e-mail?

Measuring and Test Technology:	support@gossenmetrawatt.com
Industrial Measuring Technology:	support.industrie@gossenmetrawatt.com

Enquiries concerning training and seminars can also be submitted by e-mail and online:

training@gossenmetrawatt.com

https://www.gossenmetrawatt.de/en/knowledge/webinars/

Please contact GMC-I Service GmbH for repairs, replacement parts and calibration[1]:

+49 911 817718-0

service@gossenmetrawatt.com

https://www.gmci-service.com/en/

Beuthener Str. 41
90471 Nürnberg
Germany

1. DAkkS calibration laboratory per DIN EN ISO/IEC 17025,
accredited by the Deutsche Akkreditierungsstelle GmbH under reference number D-K-15080-01-01.

12 CERTIFICATIONS

12.1 CE DECLARATION

The instrument fulfills all requirements of applicable EU directives and national regulations. We confirm this with the CE mark.
The CE declaration can be found on our website:

https://www.gossenmetrawatt.de/en/service-support/download-center/

12.2 CALIBRATION CERTIFICATE

A calibration certificate is included with the instrument.

12.3 TEST REPORT

A test report is included with the instrument.

13 DISPOSAL AND ENVIRONMENTAL PROTECTION

Proper disposal makes an important contribution to the protection of our environment and the conservation of natural resources.

ATTENTION

Environmental Damage

Improper disposal results in environmental damage.

- Follow the instructions concerning return and disposal included in this section.

The following comments refer specifically to the legal situation in the Federal Republic of Germany. Owners or end users who are subject to other regulations must comply with the respective local requirements and implement them correctly on site. Further information can be obtained, for example, from the responsible authorities or local distributors.

Waste Electrical Equipment, Electrical or Electronic Accessories and Waste Batteries (including rechargeable batteries)

Electrical equipment and batteries (including rechargeable batteries) contain valuable raw materials that can be recycled, as well as hazardous substances which can cause serious harm to human health and the environment, and they must be recycled and disposed of correctly.



The symbol at the left depicting a crossed-out garbage can on wheels refers to the legal obligation of the owner or end user (German electrical and electronic equipment act ElektroG and German battery act BattG) not to dispose of used electrical equipment and batteries with unsorted municipal waste (“household trash”). Waste batteries must be removed from the old device (where possible) without destroying them and the old device and the waste batteries must be disposed of separately. The battery type and its chemical composition are indicated on the battery’s labelling. If the abbreviations “Pb” for lead, “Cd” for cadmium or “Hg” for mercury are included, the battery exceeds the limit value for the respective metal.

Please observe the owner’s or end user’s responsibility with regard to deleting personal data, as well as any other sensitive data, from old devices before disposal.

Old devices, electrical or electronic accessories and waste batteries (including rechargeable batteries) used in Germany can be returned free of charge to Gossen Metrawatt GmbH or the service provider responsible for their disposal in compliance with applicable regulations, in particular laws concerning packaging and hazardous goods. Waste batteries must be returned in the discharged state or with appropriate precautions against short circuiting. Further information regarding returns can be found on our website.

Packaging Materials

We recommend retaining the original packaging materials in case you might require servicing or calibration in the future.



WARNING

Danger of Asphyxiation Resulting from Foils and Other Packaging Materials

Children and other vulnerable persons may suffocate if they wrap themselves in packaging materials, or their components or foils, or if they pull them over their heads or swallow them.

- Keep packaging materials, as well as their components and foils, out of the reach of babies, children and other vulnerable persons.

In accordance with German packaging law (VerpackG), the user is obligated to correctly dispose of packaging and its components separately, and not together with unsorted municipal waste (“household trash”).

Packaging which is not subject to so-called system participation is returned to the appointed service provider. Further information regarding returns can be found on our website.

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CONTACT US

Gossen Metrawatt GmbH
Südwestpark 15
90449 Nürnberg
Germany

+49 911 8602-0
+49 911 8602-669
info@gossenmetrawatt.com
www.gossenmetrawatt.com