BENNING

Operating manual

Translation of the German original version



BENNING PV 125

5361 / 11/2025 en

Legal notice

Notes concerning the documentation

Ensure that the applicable documentation is used for this product. For safe handling, knowledge that is provided in these instructions is required.

The product may only be handled while following this documentation, particularly the safety instructions and warnings it contains. The personnel must be qualified for the respective task and have the capability to recognise risks and prevent possible dangers.

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General non-discrimination

Benning is aware of the importance of language with regard to the gender equality and endeavors to take this into account at all times. To improve readability, we have refrained from consistently using differentiating formulations.

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1 Introduction

The battery-operated PV installation tester BENNING PV 125 described here (in the following only referred to as “device”) is intended for the following tests:

Commissioning tests and periodic inspection of grid-connected photovoltaic systems in compliance with IEC / DIN EN 62446-1 (VDE 0126-23-1) and IEC / DIN EN 62446-2 (VDE 0126-23-2) with test procedure of category 1.

The device enables you to perform the following tests and measurements:

- Protective conductor resistance measurement with a testing current of 200 mA-DC
- Automatic display of the voltage polarity
- Open-circuit voltage measurement on the PV module / PV string up to 1 500 V-DC
- Short-circuit current measurement on the PV module / PV string up to 25 A-DC
- Insulating resistance measurement with testing voltages of 250 V-DC, 500 V-DC, 1 000 V-DC or 1 500 V-DC
- Operating current and operating power measurement with optional TRUE RMS digital current clamp multimeter BENNING CM 3-PV up to 400 A-DC / 600 kW
- Measurement of the insolation, PV module temperature and ambient temperature by means of the optional insolation and temperature measuring instrument BENNING SUN 3

Further information

http://tms.benning.de/pv125

On the Internet, you will find the following additional information directly at the specified link or at www.benning.de (product search):

- Operating manual of the device in several languages
- Further information depending on the device (e. g. brochures, technical reports, FAQs)

1.1 Naming convention

Battery

In this operating manual, the term “battery” is used to refer to accumulators.

1.2 General notes

Target group

This operating manual is intended for the following groups of people:

- Qualified electricians and qualified technical personnel

Required basic knowledge

To understand these operating manual, you will need general knowledge of testing and measuring equipment. Moreover, you will need basic knowledge of the following issues:

- General electrical engineering

Purpose of the operating manual

This operating manual describes the device and provides you information about how to handle it.

Keep this operating manual in a safe place for later use. Read this operating manual before handling the device and follow the instructions.

NOTE

Disclaimer of liability

Please make sure that any person using the device has read and understood the instructions of this operating manual before handling the device and that the instructions are adhered to in all points. Non-observance of this operating manual might result in product damage, property damage and/or personal injury.

Benning assumes no liability for damage and malfunctions resulting from the failure to observe the instructions in this operating manual.

The devices are subject to continuous further development. Benning reserves the right to make changes to the device's design, configuration and technology. The information in this operating manual corresponds to the state of technical knowledge at the time of printing. For this reason, no claims for certain device characteristics can be derived from the contents of this operating manual.

Information in this operating manual can be changed at any time without prior notice. Benning is not obligated to make amendments to this operating manual or to keep it up to date.

Direct any technical questions to Technical Support [page 9].

Trademarks

All trademarks used are the property of their respective owners, even if they are not separately marked as such.

1.3 History

Release number	Amendments
11/2025	• Initial release

Table 1: History

1.4 Service & support

Please contact your specialty retailer or the BENNING Service Center for any repair or service work that might be required.

Technical Support

Please contact our Technical support for technical questions on handling the device.

Phone:	+49 2871 93-555
Fax:	+49 2871 93-6555
E-Mail:	helpdesk@benning.de
Internet:	www.benning.de

Returns management

Easily and conveniently use the BENNING returns portal for a quick and smooth returns processing:

https://www.benning.de/service-de/retourenabwicklung.html

Phone:	+49 2871 93-554
E-Mail:	returns@benning.de

Return address

BENNING Elektrotechnik und Elektronik GmbH & Co. KG
Retourenmanagement
Robert-Bosch-Str. 20
D - 46397 Bocholt

2 Safety

2.1 Warning system

This operating manual contains notes that must be taken into consideration for your personal safety and in order to avoid injuries and damage to property. Warnings about your personal safety and to prevent personal injuries are marked with a warning triangle. Warnings on sole prevention of material damage are shown without a warning triangle. The warnings are shown in descending order depending on the hazard level as follows.



⚠ DANGER

Extremely dangerous situation for humans

If you do not pay attention to this warning, irreversible or deadly injuries will occur.



⚠ WARNING

Hazard to humans

If you do not pay attention to this warning, irreversible or deadly injuries could occur.



⚠ CAUTION

Minor hazard to humans

If you do not pay attention to this warning, minor or moderate injuries could occur.



NOTICE

Danger to property, not to persons

If you do not pay attention to this warning, material damage could occur.

If multiple hazard levels occur, the warning for the highest respective hazard level will be used. In addition, a warning about personal injuries can also include a warning about material damage.

2.2 Standards applied

The device has been built and tested in compliance with the following directives and standards.

- 2014/30/EU
- 2014/35/EU
- 2014/53/EU
- IEC / DIN EN 61010-1 (VDE 0411-1)
- IEC / DIN EN 61010-2-034 (VDE 0411-2-034)
- IEC / DIN EN 61326-1 (VDE 0843-20-1)
- IEC / DIN EN 61557-1 (VDE 0413-1)
- IEC / DIN EN 61557-2 (VDE 0413-2)
- IEC / DIN EN 61557-4 (VDE 0413-4)
- IEC / DIN EN 61557-10 (VDE 0413-10)

- DIN EN 300 220-2
- DIN EN 301 489-3

2.3 Symbols used

Symbols on the device

Symbol	Meaning
	Please observe the information provided in this operating manual in order to avoid dangers.
	Warning of electrical danger! Please observe the information provided in this operating manual in order to avoid dangers.
CAT I	Measurement category I is applicable to testing and measuring circuits which have no direct connection to the mains.
CAT II	Measuring category II is applicable to testing and measuring circuits which are directly connected to user connections (e. g. sockets) of the low-voltage mains installation.
CAT III	Measuring category III is applicable to testing and measuring circuits connected to the distribution circuit of the low-voltage mains installation of a building.
CAT IV	Measuring category IV is applicable to testing and measuring circuits connected to the feeding point of the low-voltage mains installation of a building.
	The device complies with EU directives.
	The device complies with directives applicable in Great Britain.
	At the end of product life, dispose of the unserviceable device via appropriate collecting facilities provided in your community.
	The device is provided with protective insulation (protection class II).
	Please observe the operating manual.
	This symbol indicates the inserted battery.
	This symbol indicates a built-in fuse.
	(DC) direct voltage or direct current
	(AC) alternating voltage or alternating current
	Earth (voltage to earth)
	Bluetooth® interface for data exchange
	Creating documentation and reports via BENNING Test Equipment Cloud (BTEC)
	No voltages >1 650 V must be applied to the device.

Table 2: Symbols on the device

Symbols used in the operating manual

Symbol	Meaning
	General warning
	Warning of electric voltage!

Table 3: Symbols used in the operating manual

2.4 Intended use

Only use the device within the framework of the corresponding technical data. Any operating conditions that deviate from this shall be considered as improper use. Solely the user of the device shall be liable for any resulting damage.

Please note the following:

- In case of improper use, the liability and warranty claims become void. Solely the user of the device shall be liable for any damage resulting from improper use. Uses not complying with the intended use include e. g.:
  - Use of components, accessories, spare or replacement parts that have not been released and approved for the respective application by Benning
  - Non-observance, manipulation, changes or misuse of the operating manual or the instructions and notes contained therein
  - Any form of misuse of the device
  - Any use other than or beyond that described in this operating manual
- Warranty and liability claims are generally excluded if the damage is the result of force majeure.
- If any prescribed services are not performed regularly or not on time, according to the manufacturer's specifications during the warranty period, a decision about a warranty claim can only be made once the findings are available.

Direct any questions to Technical Support [page 9].

Using the device

Please observe the following basic obligations when using the device:

- The device must only be used by trained technical personnel in accordance with the described device specification. Evaluate the conditions at the measuring point before measuring. If there is a risk of injury, use personal protective equipment.
- The personnel must be qualified for the respective task.
- Observe relevant regulations on occupational safety and health as well as those on environmental protection.
- Before carrying out tests and measurements, disconnect all poles of the PV generator from the PV inverter. The PV generator must be isolated from the electric power supply! Neither the positive nor the negative pole of the PV generator must be earthed!
  Exception for power and current measurements by means of the BENNING CM 3-PV: The PV generator must be connected to the inverter.
- Make sure that all switching and disconnecting devices are open and all PV strings are insulated from each other.
- Please observe that the PV generator must not exceed the maximum open-circuit voltage of 1 500 V and the maximum short-circuit current of 25 A.

- Use the 4 mm measuring jacks only in electric circuits up to overvoltage category III with a conductor for a maximum of 1 500 V or overvoltage category IV with a conductor for a maximum of 1 000 V to earth.
- Please observe that the short-circuit currents (I_{SC}) of PV strings connected in parallel add up and might additionally increase due to existing capacitances of the PV generator. It is recommended to carry out the tests and measurements only on individual PV strings.
- Powerful PV generators with high capacitances might reduce the maximum values of the measurable open-circuit voltage of the device. If short-circuit currents are too high, the device protects itself against overload and refuses to measure. For more information, please refer to https://tms.benning.de/pv-info.
- The device may only be used in a technically perfect and safe condition. Always check the device for damages before using it.
- Please observe that the device is not designed for continuous operation. The useful life of the device is limited by software and via temperature monitoring. As soon as the internal operating temperature has reached the maximum value, the function of the device will be restricted in order to allow the device to cool down.
- Disconnect the device from the PV generator immediately after finishing the test or measurement.
- Do not touch any metal parts of the test object during tests and measurements.
- Use suitable (approved) safety measuring lines.
- The device may only be used in dry environments.
- Do not use the device in potentially explosive environments.
- Before measuring, check whether the battery is sufficiently charged to avoid any risk due to incorrect measurements.
- Battery:
  - Only use the included battery and charging base or the respective original spare parts.
  - Check the battery for leaks and damage.
  - Only use and charge the battery when it is undamaged. There is a risk of explosion and fire if the battery is damaged.
  - Only use the device with the battery compartment cover being screwed onto the device.



⚠ WARNING

Dangerous voltage

Danger to life or serious injury is possible due to contact with high electric voltage in case of incorrect operation.

- Do not touch the bare measuring probe tips of the safety measuring lines or the bare contacts of the optional alligator clips, Only touch the safety measuring lines in the area intended for your hands.
- Please note that dangerous testing voltages might be present at the device during insulating resistance measurement. These might also be applied to the measuring circuit if safety measuring lines are contacted.
- Connect the safety measuring lines to the correspondingly marked measuring jacks of the device and check them for tight fit.
- Only use approved safety measuring lines.
- When disconnecting the measuring circuit, first remove the live safety measuring line (phase) and then the neutral safety measuring line from the measuring point.



⚠ WARNING

Opening the device

Danger to life or serious injury is possible due to contact with high electric voltage when opening the device. The device might get damaged.

- Make sure that the device is free of voltage before opening the battery compartment.
- Do not open the device (except for the battery compartment).
- Please contact your specialty retailer or the returns management for any repairs [page 9].

Securing the device

If the device is not in a technically perfect and operationally safe condition, safe operation is no longer guaranteed. Make sure that the following measures are taken:

- Switch off the device.
- Remove the device from the measuring point.
- Secure the device against unintentional operation.

The following characteristics indicate that safe operation is no longer guaranteed:

- The device (housing or safety measuring lines) shows visible damage or is damp/wet.
- The insulation of the safety measuring lines is damaged.
- The device does not work properly in compliance with regulations (e. g. errors during measurements).
- The device shows recognisable consequences of prolonged storage under inadmissible conditions.
- The device shows recognisable consequences of extraordinary stress due to transport.

2.5 Special types of risks



⚠ DANGER

Bare conductors or main line carriers

Danger to life or serious injury is possible due to contact with high electric voltage when working with bare conductors or main line carriers.

- Please observe relevant regulations on occupational safety and health.
- If necessary, use appropriate protective equipment.



⚠ WARNING

Dangerous voltage

Danger to life or serious injury is possible due to contact with high electric voltage when working on live components or equipment. Even low voltages from 30 V-AC and 60 V-DC on can be dangerous to human life!

- Please observe relevant regulations on occupational safety and health.
- If necessary, use appropriate protective equipment.

3 Scope of delivery

The scope of delivery of the device includes the following components:

- 1 x installation tester for photovoltaic systems BENNING PV 125 (item no: 10241491)
- 1 x set of 4 mm measuring lines (l = 1.5 m) with test probe and alligator clip (yellow, black, red, item number: 11005062)
- 1 x set of PV measuring lines, MC4-compatible (yellow, black, item number: 11005068)
- 1 x charging base PV 125 / PV 225 (item no: 11005060)
- 1 x Li-ion battery pack PV 125 / PV 225 (11.55 V, 2 930 mAh, item no: 11005059)
- 1 x transport and storage case (item no.: 10056269)
- 1 x operating manual
- 1 x test report

Optional accessories

- Digital current clamp multimeter BENNING CM 3-PV (item no.: 11001235)
  - DC and AC current measuring range (clamp): 10 mA … 400 A
- Insolation and temperature measuring instrument BENNING SUN 3 (item no.: 11001143)
  - Insolation measuring range: 100 ... 1 500 W/m²
  - Temperature measuring range: -30 ... 125 °C
- Temperature sensor with suction cup for BENNING SUN 2 / 3 for attachment to the rear of the PV module (item no.: 050424)
- PV module holder for BENNING SUN 2 / 3 for safe attachment to the PV module (item no.: 050425)
- 40 m measuring lines BENNING TA 5 (item no.: 044039)

  Connection to Ø 4 mm safety test socket / plug, l = 40 m, with rewinder and wrist strap
- Set of PV measuring lines with Y adapter for power measurement, MC4-compatible (yellow, black, item number: 11005076)
- 1 x Li-ion battery pack PV 125 / PV 225 (11.55 V, 2 930 mAh, item no: 11005059)

4 Device description

4.1 Device structure

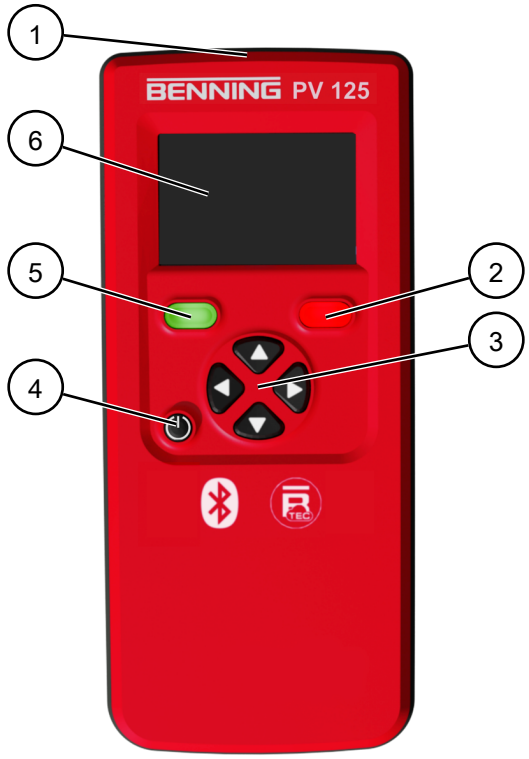


Figure 1: BENNING PV 125 device structure

1	Device top	2	Function key 2
3	Navigation keys	4	ON/OFF key
5	Function key 1	6	Digital display

Device top



Figure 2: Device top

1	Black measuring jack “-”
2	Yellow measuring jack “+”
3	Red measuring jack “R_{ISO}”

Rear panel of the device

- Battery compartment
- Notes and information about the device
- Serial number

4.2 Layout of the digital display

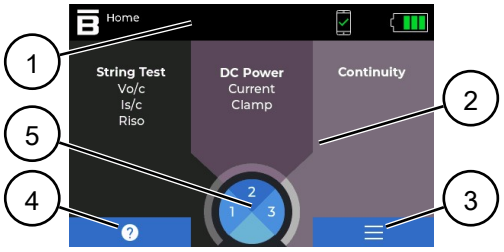


Figure 3: Digital display

1	Header	2	Main display area (menu, texts and measuring results)
3	Function of function key 2	4	Function of function key 1
5	Functions of the navigation keys		

Header

Various information is displayed in the header. Content of the header

- Current menu
- Dangerous voltages
- Remaining battery charge
- Connected devices

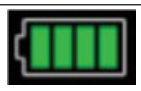
Symbol	Meaning
	The control indicator is shown if the device detects the presence of a dangerous voltage (>30 V).
	State of battery charge: Each bar corresponds to 25 % of the remaining charge. The colour of the bars depends on the charge. 1 bar: red 2 bars: yellow >2 bars: green
	The device is paired to the insolation and temperature measuring instrument BENNING SUN 3.
	The device is paired to a mobile device via the Bluetooth® interface.

Table 4: Symbols in the header

Navigation keys

If navigation keys are assigned a function, this will be shown on the digital display. Press the corresponding navigation key to execute this function.

Symbol	Meaning
	Executes the displayed cursor movements for data entry, navigation in a menu or movement within a page.
	Selects the saved automatic measurements on the start screen (“Home”).
	Selects the applied testing voltage before starting an insulating resistance measurement. You can select the following testing voltages: 250 V-DC, 500 V-DC, 1 000 V-DC, 1 500 V-DC. For the string test, there is an additional “Skip” option. If you select “Skip”, the insulating resistance measurement will not be carried out.
	Deletes all selected elements or results from the memory management menus.
	Selects the desired option in the “Restore Defaults” menu and confirms the selected option.

Table 5: Navigation keys

Function keys

If function keys are assigned a function, this will be shown on the digital display. Press the corresponding function key to execute this function.

The function keys light up in different colours depending on their function.

- Blue: Executing a function
- Green: Starting a test
- Red: Cancelling a test

Symbol	Designation	Description
	Home	Switches to the start screen.
	Menu	Opens the main menu.
	Back	Switches to the previous screen.
	Apply	Confirms the selected option.
	Start Test	Starts a test or an automatic measurement.
	Save	Saves test details including the results.
	About	Shows information on the hardware and firmware of the device.
	Search	Searches for the BENNING CM 3-PV to be paired in the “Pair to Current Clamp” menu item.

Table 6: Function keys

4.3 Menu

Press the “Menu” function key ☰ to open the main menu. You can then navigate through the menu using the navigation keys.

Menu structure

Main Menu
- > Memory Management
  - > View Results
  - > Delete Test Results
  - > Restore to Default
    - > Clear Memory
    - > Default Settings
- > General Settings
  - > Time/Date Settings
  - > Display Settings
    - > Backlight Timeout
    - > Slider for display brightness
  - > Auto Shut Off
    - > Auto Shut Off Time
  - > Language
- > Manual Mode
  - > Current Clamp
  - > Continuity
  - > Riso
  - > Panel Voltage
- > Connectivity Settings
  - > Pair to Current Clamp
  - > Pair to Irradiance Meter

4.4 Functions

Switching the device ON/OFF

To switch the device on or off, press and hold the ON/OFF key for approx. 2 seconds.

The device switches off automatically after the set switch-off time (“Auto Shut Off”). You can select switch-off times from 3 to 15 minutes or disable the switch-off time.

Date and time

The date and time have been preset at the factory. You can also enter the date and time manually [▷ page 27]. When connected to the BTEC app, the time on the device automatically synchronises with the time on the mobile device.

4.4.1 Automatic measurements

You can start automatic measurements via the start screen (“Home”) [▷ page 39]. This function allows you to carry out measurements one after the other using predefined test sequences. You can save automatic measurements.

AC/DC voltages at the black measuring jack “-” and yellow measuring jack “+” are displayed automatically.

Requirements

- Approved safety measuring lines
- Please observe the requirements for measuring [▷ page 30].

Procedure

1. Select the desired automatic measurement using the respective navigation key.
2. Press the “Start Test” function key lit in green to start the automatic measurement. After each measurement, the measuring result will be displayed. As soon as all measuring results are displayed, the test sequence of the automatic measurement is complete.

Symbol	Meaning
	Test is carried out.
	Test was passed (as far as limits exist).
	Test was not passed (as far as limits exist). Or test was cancelled by pressing the stop key.

Table 7: Symbols for automatic measurements

4.4.2 Manual measurements

You can carry out all measurements as manual measurements [▷ page 32]. These are required e. g. for diagnostic tests. Manual measurements cannot be saved.

AC/DC voltages at the black measuring jack “-” and yellow measuring jack “+” are displayed automatically. Exception: Insulating resistance measurement “Riso”

Requirements

- Approved safety measuring lines
- Please observe the requirements for measuring [▷ page 30].

Procedure

1. Press the “Menu” function key .
2. Navigate to “Manual Mode” using the navigation keys.
3. Navigate to the desired measurement and select it using the “Apply” function key .
4. Press the “Start Test” function key lit in green to start the measurement.
   After measurement, the measuring result will be displayed.
5. Press the “Back” function key lit in blue to return to the previous screen.

4.4.3 Memory management

4.4.3.1 Saving data records and adding references

The device can save up to 1 000 data records. A data record contains any combination of tests that were carried out as part of an automatic measurement. Manual measurements cannot be saved.

Requirements

- The automatic measurement to be saved is complete.
- You know the required reference data (“Site Location”, “Inverter Number”, “String Number”).

Procedure

1. Press the “Save” function key lit in blue to save the measurements.
   The “User Input > Site Location” screen opens.
2. Enter the object name (name or location of the object, “Site Location”) and save it.
   The “User Input > Inverter Number” screen opens.
3. Enter the inverter ID (“Inverter Number”) and save it.
   The “User Input > String Number” screen opens.
4. Enter the string ID (“String Number”) and save it.
   Successful saving will be acknowledged with a message. The data record has been created.

4.4.3.2 Displaying measurements (“View Results”)

You can display all measurements.

Menu

- “Main Menu > Memory Management > View Results”

Requirements

- You have saved at least one measurement.

Procedure

1. Select the desired measurement using the navigation keys and press the “Apply” function key to confirm.
2. Select the desired part of the measurement using the navigation keys and press the “Apply” function key to confirm.
3. Press the “Back” function key repeatedly until you got to the desired menu item.

4.4.3.3 Deleting measurements (“Delete Test Results”)

You can delete selected measurements.

Menu

- “Main Menu > Memory Management > Delete Test Results”

Requirements

- You have saved at least one measurement.

Procedure

1. Select the measurements to be deleted using the navigation keys and press the “Apply” function key  to confirm.
2. Press the navigation key  to delete the selected measurements.
3. Confirm the deletion process pressing the “Apply” function key  or cancel the deletion process pressing function key 1.

4.4.3.4 Resetting default values (“Restore Defaults”)

The “Restore Defaults” menu includes two options:

- “Clear Memory” deletes all saved measurements.
- “Default Settings” deletes all saved measurements and resets the following data to the default settings:
  - Distance to paired BENNING CM 3-PV
  - Channel ID for pairing of the BENNING SUN 3
  - Names for object, inverter ID and string ID (“Site Location”, “Inverter Number” and “String Number”)

Menu

- “Main Menu > Memory Management > Restore Defaults”

Procedure

1. Select the desired option using the navigation keys and press the “Apply” navigation key  to confirm.
2. Press the “Start Test” function key .

4.4.4 BENNING SUN 3

The insolation and temperature measuring instrument BENNING SUN 3 is an optional accessory and can send the following measured values to the device via radio transmission [page 29]:

- Insolation (W/m²)
- PV module temperature
- Ambient temperature
- Date and time stamp

Indications on the digital display of the device

- If the  symbol is visible in the header, the BENNING SUN 3 is connected to the device via the Long-Range (LoRa) radio interface.
- Within radio range, measured values are displayed right next to the  symbol underneath the BENNING logo.
- Within radio range, the measured insolation value (W/m²) is displayed.
- If the temperature sensor is connected to the “PROBE” socket, the PV module temperature (“Panel”) and ambient temperature (°C) are also displayed when the device is within radio range.
- The values are only shown during the automatic measurements “String Test” and “DC Power” as well as during the manual measurements “Panel Voltage” and “Current Clamp”.
- The BENNING SUN 3 switches off automatically after the following time periods:
  - 15 minutes unused in unpaired state
  - 30 minutes in the dark
  - 12 hours after switching on for the first time

4.4.5 BENNING CM 3-PV

The TRUE RMS digital current clamp multimeter BENNING CM 3-PV is an optional accessory. When paired, it can send the current measured by means of the measuring clamp to the device via radio transmission [page 28].

- The rotary switch of the BENNING CM 3-PV must be in position “A”. DC must be set using the “SELECT” key.
- The device must be paired and connected to the BENNING CM 3-PV via radio connection.
- The values are only shown during the automatic measurement “DC Power” and the manual measurement “Current Clamp”. The digital display shows “Connected” above the “Back” function key .

4.5 Measuring ranges

Measuring accuracy

The measuring accuracy is specified as the sum of the following:

- Relative part of the measured value
- Number of digits (counting steps of the last digit)

The specified measuring accuracy applies at a temperature of 24 °C ±6 °C and a relative air humidity lower than 80 %.

4.5.1 Resistance ranges

Protective conductor resistance R_{PE}

Measuring range	Resolution	Measuring accuracy
0.05 … 0.09 Ω	Max. 0.01 Ω	±(2 % + 1 digit)
0.10 … 0.19 Ω		±(2 % + 2 digits)
0.20 … 1.99 Ω		±(2 % + 3 digits)
2 … 4.9 Ω		±(2 % + 2 digits)
5 … 199 Ω		±(2 % + 5 digits)

Table 8: Measuring range for measuring the protective conductor resistance R_{PE}

- Testing current: >200 mA (2 Ω)
- Open-circuit voltage: >4 V-DC
- Null balance: up to approx. 10 Ω
- Number of periodic inspections (IEC 61557-4): approx. 4 000 (1 s test)

Insulating resistance R_{ISO}

Measuring range	Resolution	Measuring accuracy
0.05 ... 0.19 MΩ	0.01 MΩ	±(5 % + 1 digit)
0.20 ... 1.99 MΩ	0.01 MΩ	±(5 % + 3 digits)
2.0 ... 5.0 MΩ	0.1 MΩ	±(5 % + 2 digits)
5.1 ... 19.9 MΩ	0.1 MΩ	±(5 % + 5 digits)
20 ... 99 MΩ	1 MΩ	±(5 % + 5 digits)
>99 MΩ	1 MΩ	±(10 % + 5 digits)

Table 9: Measuring accuracy and resolution depending on the measuring range of the insulating resistance R_{ISO}

V_{ISO}	Limit of the insulating resistance
250 V	0.5 MΩ
500 V	1.0 MΩ
1 000 V	1.0 MΩ
1 500 V	1.0 MΩ

Table 10: Preset limits of the insulating resistance

Measuring ranges (IEC 61557-2) for automatic measurement “String Test”

Measuring range	Viso
0.05 ... 200 MΩ	250 V / 500 V
0.05 ... 999 MΩ	1 000 V / 1 500 V

Table 11: Measuring ranges of the insulating resistance R_{ISO} in the automatic measurement “String Test”

Testing voltage: 250 V-DC, 500 V-DC, 1 000 V-DC or 1 500 V-DC (positive deviation up to 20 %)

- Testing current: >1 mA, <2 mA in case of a short-circuit
- Number of periodic inspections (IEC 61557-2): approx. 4 000 (1 s test)
- Max. system capacitance: 2 µF

Measuring ranges (IEC 61557-2) for manual measurement “Riso”

Measuring range	Viso
0.05 ... 300 MΩ	250 V
0.05 ... 500 MΩ	500 V
0.05 ... 999 MΩ	1 000 V / 1 500 V

Table 12: Measuring ranges of the insulating resistance R_{ISO} in the manual measurement “Riso”

Testing voltage: 250 V-DC, 500 V-DC, 1 000 V-DC or 1 500 V-DC (positive deviation up to 20 %)

- Testing current: >1 mA, <2 mA in case of a short-circuit
- Number of periodic inspections (IEC 61557-2): approx. 4 000 (1 s test)
- Max. system capacitance: 2 µF

4.5.2 Voltage ranges

Open-circuit voltage V_{OC} of the PV module/ PV string and voltage

Measuring range	Resolution	Measuring accuracy (AC: 50 … 60 Hz, DC)
10 … 1 500 V-DC	Max. 0.1 V	±(0.5 % + 2 digits)
-10 … -440 V-DC	0.1 V	±(5 % + 2 digits)
10 … 440 V-AC	0.1 V	±(5 % + 2 digits)

Table 13: Measuring range for measuring the open-circuit voltage V_{OC} of the PV module/ PV string and the voltage

4.5.3 Current ranges

Short-circuit current I_{SC} of the PV module or PV string

Measuring range	Resolution	Measuring accuracy
0.50 … 25.00 A-DC	Max. 0.01 A	±(1 % + 2 digits)

Table 14: Measuring range for measuring the short-circuit current I_{SC} of the PV module or PV string

Current via TRUE RMS digital current clamp multimeter BENNING CM 3-PV (optional)

Measuring range	Resolution	Measuring accuracy (AC: 50 … 60 Hz, DC)
0.1 … 400.0 A-DC	0.1 A	±(2 % + 5 digits)

Table 15: Measuring range for measuring the current by means of the TRUE RMS digital current clamp multimeter BENNING CM 3-PV (optional)

4.5.4 Power ranges

Power of the PV module / PV string (voltage via PV measuring lines with Y adapter and MC4-compatible connectors and current via BENNING CM 3-PV)

Measuring range	Resolution	Measuring accuracy
0.50 … 600 kW	0.01 kW	±(6 % + 2 digits)

Table 16: Measuring range for power measurement of the PV module / PV string

5 Operation

The device enables you to carry out various tests and measurements.

5.1 Configuration

5.1.1 Selecting the language

Go to “Language” to select the desired language.

Menu

- “Main Menu > General Settings > Language”

Procedure

1. Select the desired language and confirm it.
   – English
   – German
2. Press the “Back” function key to go to the higher menu level.

5.1.2 Setting the date and the time

Go to “Time/Date Settings” to change the date format, date and time.

Menu

- “Main Menu > General Settings > Time/Date Settings”

Procedure

1. Select the desired date format and confirm it.
   – DD/MM/YYYY
   – MM/DD/YYYY
   – YYYY/MM/DD
2. Select the desired date and confirm it.
3. Select the desired time and confirm it. The entered values have been saved.
4. Press the “Back” function key to go to the higher menu level.

5.1.3 Setting the switch-off time

Go to “Auto Shut Off” to select the time after which the device switches off (automatic switch-off).

Menu

- “Main Menu > General Settings > Auto Shut Off”

Procedure

1. Select the desired switch-off time and confirm it. The entered value will be saved.
   – Disabled
   – 3Min, 6Min, 9Min, 12Min, 15Min
2. Press the “Back” function key to go to the higher menu level.

5.1.4 Setting the display settings

Go to “Display Settings” to select both the brightness of the backlight and the time after which it is dimmed.

Menu

- “Main Menu > General Settings > Display Settings”

Procedure

1. Use the navigation keys ▲ or ▼ to select the desired time.
   – 30Sek, 1Min, 2Min, 3Min, 5Min
2. Use the navigation keys ► or ◄ to select the desired brightness. It will be visualised via a bargraph indication. Press the “Apply” function key to save the selected settings.
3. Press the “Back” function key to go to the higher menu level.

5.1.5 Pairing the device with the BENNING CM 3-PV (optional)

Requirements

- The BENNING CM 3-PV (optional accessory) is in the vicinity of the device.
- Please observe the specifications given in the operating manual of the BENNING CM 3-PV.
- Make sure that there are no electric devices in direct vicinity.

Procedure

1. Switch on the digital current clamp multimeter BENNING CM 3-PV.
2. Switch on the device.
3. In the device menu, navigate to “Connectivity Settings > Pair to Current Clamp”.
4. Press the “Apply” function key.
5. Press the “Search” function key to display all available BENNING CM 3-PV devices.
6. Select the desired BENNING CM 3-PV using the device ID. The ID can be found on the back in the area of the measuring clamp. The last 6 digits of the device ID correspond to the serial number.
7. Press the “Apply” function key. You will see the message “Connection status”: “Connected”.
8. Press the “Apply” function key.
9. Press the “Back” function key to go to the higher menu level.

Result

You have paired the device with the BENNING CM 3-PV. The radio connection is active.

5.1.6 Pairing the device with the BENNING SUN 3 (optional)

Requirements

- The BENNING SUN 3 (optional accessory) is in the vicinity of the device.
- Please observe the specifications given in the operating manual of the BENNING SUN 3.
- Make sure that there are no electric devices in direct vicinity.

Procedure

1. Switch on the device.
2. Switch on the BENNING SUN 3. Simultaneously press the keys and .
3. Simultaneously press the keys and of the BENNING SUN 3 for approx. 2 s.
4. Release both keys. You will see the active channel ID.
5. If necessary, change the channel ID (0 to 5) using the or key and keep it in mind.
6. Save the channel ID using the key.
7. In the device menu, navigate to “Connectivity Settings > Pair to Irradiance Meter”.
8. Press the “Apply” function key. You will see the active channel ID.
9. Select the same channel ID using the navigation keys.
10. Press the “Apply” function key. You will see the message “Configuration”: “Finished saving successfully!”.
11. Press the “Apply” function key. You will see the message “Restart needed”: “Please restart both devices.”.
12. Press the “Apply” function key.
13. Switch off the device.
14. Switch off the BENNING SUN 3. Simultaneously press the keys and for approx. 2 s.

Result

You have paired the device with the BENNING SUN 3. As soon as you switch on both the device and the BENNING SUN 3, the radio connection will be enabled.

- A permanently shown triangle above the key on the digital display of the BENNING SUN 3 indicates that a device has been paired.
- If the radio connection is active on a paired device, this is additionally indicated by a flashing triangle above the key on the digital display.
- If the BENNING SUN 3 has never been paired before, a slowly flashing triangle is displayed above the key (2 S on and 10 s off).

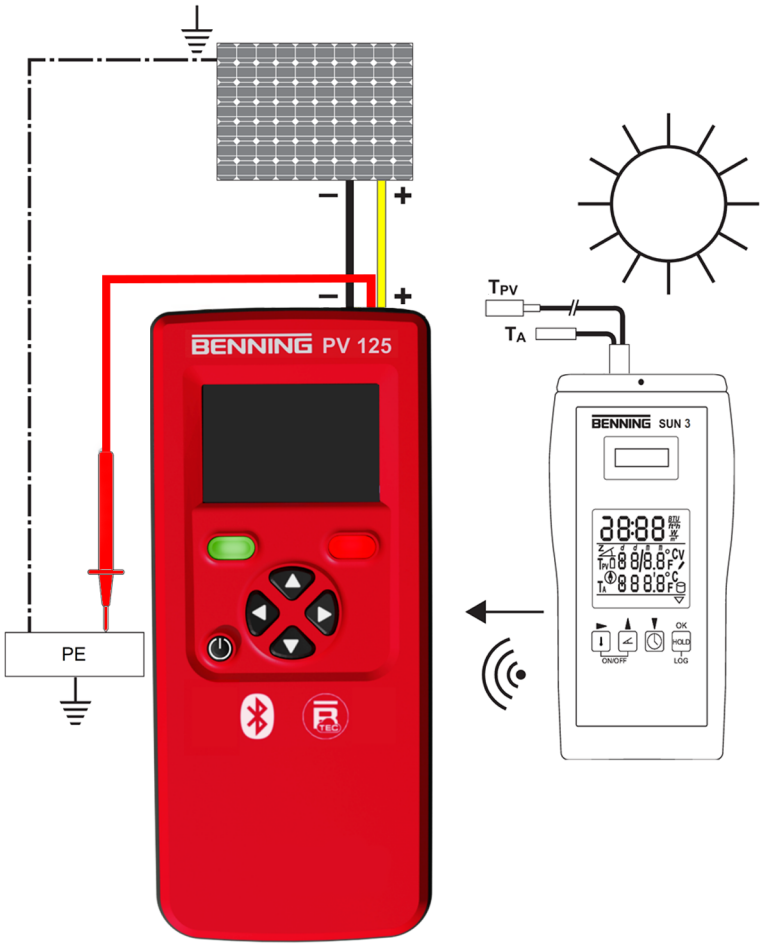


Figure 4: Radio connection to the BENNING SUN 3

5.2 Requirements for tests and measurements

Please observe the following basic requirements for tests and measurements:

- Before carrying out tests and measurements, disconnect all poles of the PV generator from the PV inverter. The PV generator must be isolated from the electric power supply! Neither the positive nor the negative pole of the PV generator must be earthed!
  Exception for power and current measurements by means of the BENNING CM 3-PV: The PV generator must be connected to the inverter.
- Make sure that all switching and disconnecting devices are open and all PV strings are insulated from each other.
- Please observe that the PV generator must not exceed the maximum open-circuit voltage of 1 500 V and the maximum short-circuit current of 25 A.
- It is recommended to carry out the tests and measurements only on individual PV strings.
- No power optimisers are installed in the PV generator.
- Only connect the device according to the connection diagram of the associated test or measurement.
- The battery of the device is charged.
- The yellow "+" measuring jack and the black "-" measuring jack can also be used to measure an AC voltage of up to 440 V.
- Only use approved safety measuring lines [page 31].
- Disconnect any safety measuring lines not required for the respective test or measurement from the device.

- Please consider sources of interference that might be present. Strong sources of interference in the vicinity of the device might involve unstable readings and measuring errors.
- Disconnect the device from the test object immediately after finishing the test or measurement as well as during the cool-down phase.



⚠ DANGER

Maximum admissible voltage

Danger to life or serious injury is possible due to contact with high electric voltage.

- Use the device only in electric circuits up to overvoltage category III with a conductor for a maximum of 1 500 V or overvoltage category IV with a conductor for a maximum of 1 000 V to earth.

5.3 Connecting the safety measuring lines

For certain tests and measurements, it is necessary to connect the safety measuring lines to the device.

Requirements

- Please observe the requirements for measuring [page 30].
- Safety measuring lines

  The safety measuring lines must be approved for the device (e. g. safety measuring lines included in the scope of delivery) and be in a technically perfect and operationally safe condition.
  - Check the specifications regarding nominal voltage and nominal current.
  - Check the insulation of the safety measuring lines.
  - Check the safety measuring lines for continuity.
  - Replace defective safety measuring lines.
- During tests and measurements, only touch the safety measuring lines in the area intended for your hands.



⚠ WARNING

Dangerous voltage

Danger to life or serious injury is possible due to contact with high electric voltage in case of incorrect operation.

- Do not touch the bare measuring probe tips of the safety measuring lines or the bare contacts of the optional alligator clips, Only touch the safety measuring lines in the area intended for your hands.
- Please note that dangerous testing voltages might be present at the device during insulating resistance measurement. These might also be applied to the measuring circuit if safety measuring lines are contacted.
- Connect the safety measuring lines to the correspondingly marked measuring jacks of the device and check them for tight fit.
- Only use approved safety measuring lines.
- When disconnecting the measuring circuit, first remove the live safety measuring line (phase) and then the neutral safety measuring line from the measuring point.

Procedure for 4 mm safety measuring lines

1. Connect the black 4 mm safety measuring line to the black 4 mm jack of the device.
2. Connect the yellow 4 mm safety measuring line to the yellow 4 mm jack of the device.
3. Connect the red 4 mm safety measuring line to the red 4 mm jack of the device.

Procedure for PV safety measuring lines

1. Connect the black PV safety measuring line to the black 4 mm measuring jack of the device.
2. Connect the yellow PV safety measuring line to the yellow 4 mm measuring jack of the device.

5.4 Manual measurements

5.4.1 Open-circuit voltage and short-circuit current measurements

Go to “Panel Voltage” to start the open-circuit voltage and short-circuit current measurements. The following measurements will be made:

- Measurement of the PV open-circuit voltage V_{OC}
- Measurement of the PV short-circuit current I_{SC}

Menu

- “Main Menu > Manual Mode > Panel Voltage”

Requirements

- Please observe the requirements for measuring [page 30].
- Corresponding measuring ranges [page 23]
- Stable insolation conditions
- Approved safety measuring lines



Figure 5: Open-circuit voltage and short-circuit current measurements

Procedure

1. Connect the PV safety measuring lines to the device [page 31].
2. Bring the PV safety measuring lines into contact with the individual PV module or the individual PV string.

   Make sure that the respective safety measuring lines are contacted properly and safely with the PV generator.
3. Press the “Start Test” function key to start the “Panel Voltage” measurement.

   When the measurement is completed, the measured values will be shown on the digital display.

5.4.2 Insulating resistance measurement (point-to-point, P2P)

Go to “Riso” to carry out an insulating resistance measurement.

Menu

- “Main Menu > Manual Mode > Riso”

Requirements

- Please observe the requirements for measuring [page 30].
- Corresponding measuring ranges [page 23]
- Approved safety measuring lines
- Measuring point must be free of voltage

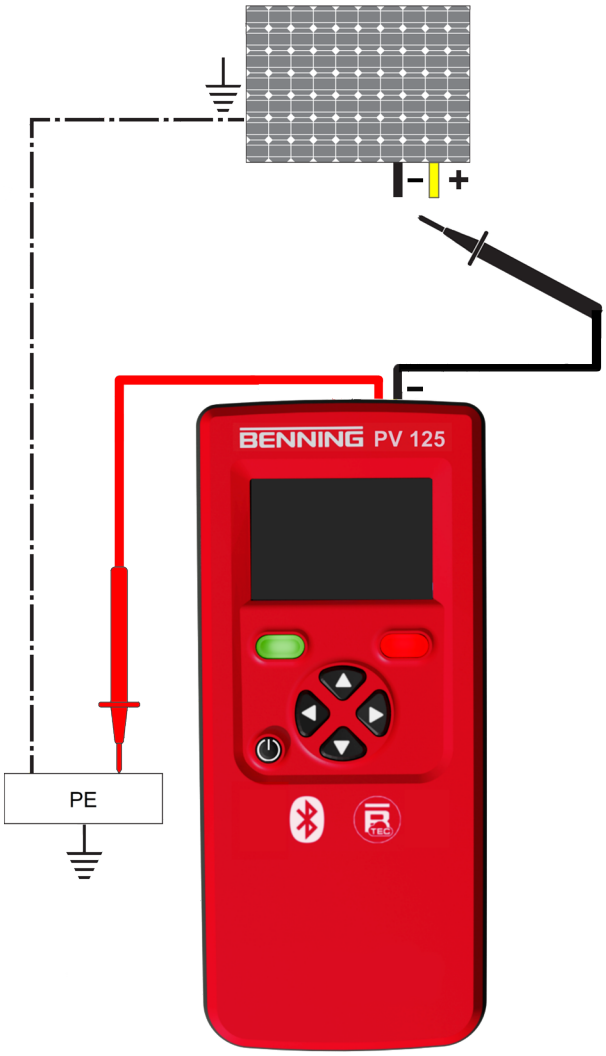


Figure 6: Insulating resistance measurement (point-to-point, P2P)

Procedure

1. Connect the black 4 mm safety measuring line to the black “-” measuring jack.
2. Bring the black 4 mm safety measuring line into contact with one of the two connecting cables (positive pole or negative pole) of the PV module / PV string. Make sure that the black 4 mm safety measuring line is contacted properly and safely with the connecting cable.
3. Connect the red 4 mm safety measuring line to the red measuring jack.
4. Bring the red 4 mm safety measuring line into contact with a metal part (frame or mounting system) of the PV generator.

   If the PV generator is properly earthed, you can alternatively measure the insulating resistance against a safe earth connection (e. g. equipotential busbar).

   If the PV generator is not earthed, first measure the insulating resistance against a metal part (frame or mounting system) of the PV generator and then against a safe earth connection (e. g. equipotential busbar).
5. Select the desired insulation test voltage of 250 V-DC, 500 V-DC, 1 000 V-DC or 1 500 V-DC. To do this, press the “U+” navigation key until the desired insulation test voltage is shown on the digital display.
6. Start the insulating resistance measurement. To do this, press the “Start Test” function key.

   When the measurement is completed, the measured values will be shown on the digital display.

   If the measured insulating resistance is higher than the preset limits, the  symbol will be shown next to the measured value on the digital display. If the measured value is lower than the limits, the  symbol will be displayed.
7. Repeat the measurement for the other connecting cable of the PV module / PV string.

5.4.3 Operating current and operating power measurements

Go to “Current Clamp” to measure the operating current and the operating power using a connected BENNING CM 3-PV digital current clamp multimeter. Select the measurement via the manual measurement “Current Clamp”. The following measurements will be made:

- Measurement of the operating voltage U
- Measurement of the operating current I_{CLAMP}
- Measurement of the operating power P

Menu

- “Main Menu > Manual Mode > Current Clamp”

Requirements

- Please observe the requirements for measuring [page 30].
- Corresponding measuring ranges [page 23]
- Stable insolation conditions
- Approved safety measuring lines
- The device is paired and connected to the digital current clamp multimeter BENNING CM 3-PV. [page 28]
- The rotary switch of the BENNING CM 3-PV must be in position “A”. DC must be set using the “SELECT” key.
- To connect the device to a PV string that is connected to an inverter, you need an optional set of PV measuring lines with Y adapter for power measurement which is MC4-compatible.

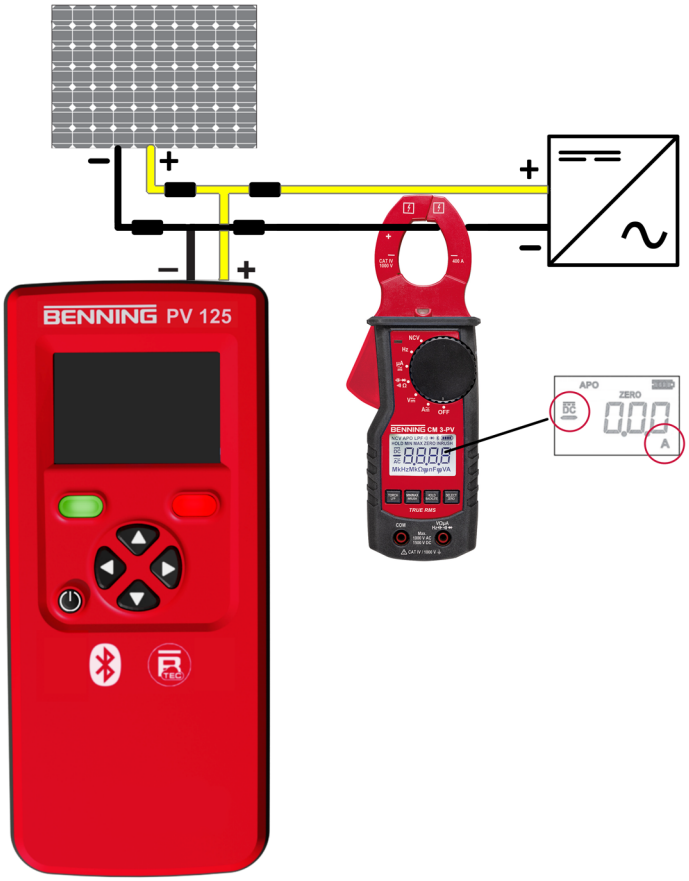


Figure 7: Operating current and operating power measurements using the BENNING CM 3-PV

Procedure

1. Connect the PV generator to the inverter and the black measuring jack “-” of the device using the black measuring line belonging to the set of PV measuring lines with Y adapter.
2. Connect the PV generator to the inverter and the yellow measuring jack “+” of the device using the yellow measuring line belonging to the set of PV measuring lines with Y adapter.
3. On the BENNING CM 3-PV, select rotary switch position A⎓.
4. Press the “SELECT / ZERO” key of the BENNING CM 3-PV to switch from AC to DC.
5. Clamp one of the two conductors by means of the measuring clamp.

   When the measurements are completed, the measured values will be shown on the digital display.

5.4.4 Null balancing of the 4 mm safety measuring lines

Before measuring the protective conductor resistance (R_{PE}) with new safety measuring lines, carry out a null balance.

Menu

- “Main Menu > Manual Mode > Continuity”

Requirements

- Approved safety measuring lines
- Please observe the requirements for measuring [page 30].



Figure 8: Null balancing of the 4 mm safety measuring lines

Procedure

1. Connect the 4 mm safety measuring lines to the device [page 31].
2. Short-circuit the two measuring probes of the 4 mm safety measuring lines by contacting them.
3. Start the null balance by pressing the navigation key ► “Null”. Null balance is carried out.
   Please note that measuring line resistances of up to 10 Ω can be compensated for.

5.4.5 Protective conductor resistance measurement

Go to “Continuity” to carry out a protective conductor resistance measurement.

Menu

- “Main Menu > Manual Mode > Continuity”

Requirements

- Please observe the requirements for measuring [▷ page 30].
- Corresponding measuring ranges [▷ page 23]
- Approved safety measuring lines
- You have carried out a null balance.
- In an error-free condition of the PV module / PV string, no voltage is applied to the measuring points.
- If a voltage
  - higher than or equal to 10 V or
  - lower than or equal to -10 V

  is applied to the test probes during measurement, the voltage U_{PE} will be displayed and the measurement will be blocked.

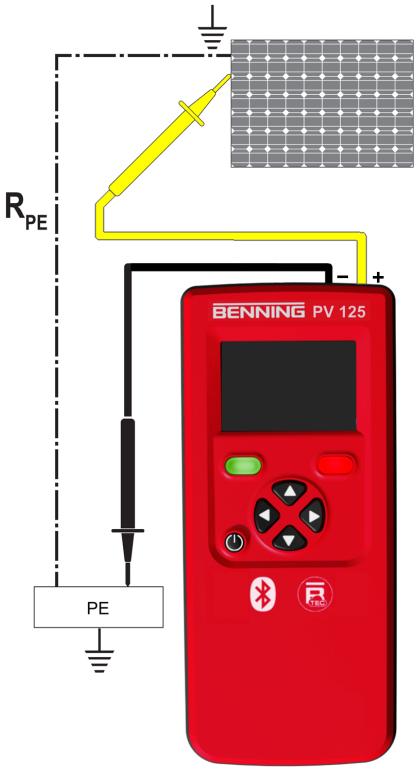


Figure 9: Protective conductor resistance measurement

Procedure

1. Connect the 4 mm safety measuring lines to the device [▷ page 31].
2. Bring the 4 mm safety measuring lines into contact with the measuring points.
3. Press the “Start Test” function key and read the measured value on the digital display.

5.5 Automatic measurements

5.5.1 String testing

Start the automatic measurement by selecting “String Test” on the start screen using the navigation keys. The following measurements will be made:

- Measurement of the PV open-circuit voltage V_{OC}
- Measurement of the PV short-circuit current I_{SC}
- Measurement of the insulating resistance R_{ISO}

  During the insulating resistance measurement, the PV generator is shorted. Measurement is made between the red measuring jack and the shorted measuring jacks “+” (yellow) and “-” (black).

Requirements

- Please observe the requirements for measuring [page 30].
- The DC polarity is correct and the DC voltage is in the range between 10 and 1 500 V.
- Corresponding measuring ranges [page 23]
- Stable insolation conditions
- Approved safety measuring lines

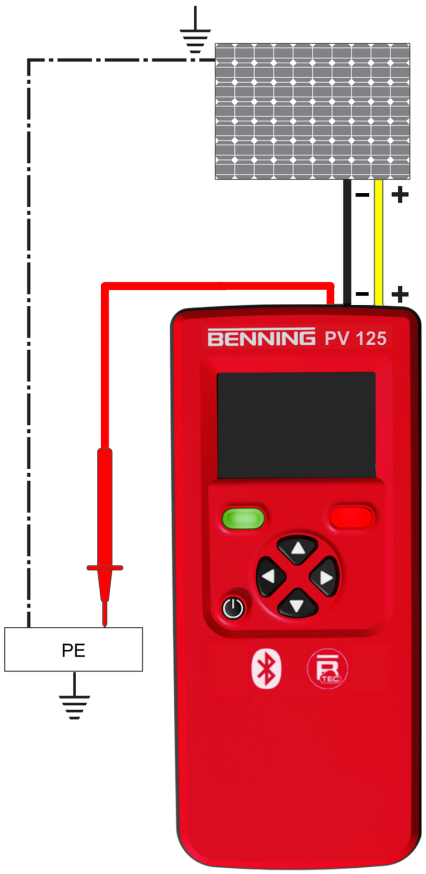


Figure 10: String testing

Procedure

1. Connect the PV safety measuring lines to the device [page 31].
2. Bring the PV safety measuring lines into contact with the individual PV module or the individual PV string.

   Make sure that the respective PV safety measuring lines are contacted properly and safely with the PV generator.

   If DC voltage is applied to the PV safety measuring lines, the PV open-circuit voltage will be measured automatically.
3. Connect the red 4 mm safety measuring line to the device [page 31].
4. Bring the red 4 mm safety measuring line into contact with a metal part (frame or mounting system) of the PV generator.

   If the PV generator is properly earthed, you can alternatively measure the insulating resistance against a safe earth connection (e. g. equipotential busbar).

   If the PV generator is not earthed, first measure the insulating resistance against a metal part (frame or mounting system) of the PV generator and then against a safe earth connection (e. g. equipotential busbar).
5. Select the desired insulation test voltage of 250 V-DC, 500 V-DC, 1 000 V-DC or 1 500 V-DC. To do this, press the “U+” navigation key until the desired insulation test voltage is shown on the digital display.

   If you select “Skip”, the insulating resistance measurement will not be carried out.
6. Start the automatic measurement. To do this, press the “Start Test” function key.

   When the measurement is completed, the measured values will be shown on the digital display.

   If the measured insulating resistance is higher than the preset limits, the  symbol will be shown next to the measured value on the digital display. If the measured value is lower than the limits, the  symbol will be displayed.
7. Press the “Save” function key to save the measured value.
8. You can assign the following test reference to the measurement:
   - Site Location
   - Inverter Number
   - String Number

5.5.2 DC power measurement

Measure the operating current and the operating power by selecting “DC Power” on the start screen using the navigation keys. Thus, you start the same measurement as with the manual measurement “Current Clamp” [page 35]. You can save the measuring results.

5.5.3 Continuity measurement

Measure the protective conductor resistance by selecting “Continuity” on the start screen using the navigation keys. Thus, you start the same measurement as with the manual measurement “Continuity” [page 38]. You can save the measuring results.

5.6 Documentation of measurements via BENNING Test Equipment Cloud (BTEC)

You can use the BENNING Test Equipment Cloud (BTEC) as an innovative cloud solution for documentation, creation of reports and management of your testing tasks.

Requirements

- Connection to the BENNING Test Equipment Cloud (BTEC) via one of the following options:
  - Mobile device with installed BTEC app (Android or iOS) and connection to the Internet
  - Bluetooth-enabled Windows PC or Apple Mac with Chrome web browser installed and connection to the Internet
- For more information, please refer to:

  http://btec-info.benning.de

6 Maintenance

The battery compartment may be opened for maintenance work. Apart from that, there are no components in the device that you can replace.



⚠ WARNING

Opening the device

Danger to life or serious injury is possible due to contact with high electric voltage when opening the device. The device might get damaged.

- Make sure that the device is free of voltage before opening the battery compartment.
- Do not open the device (except for the battery compartment).
- Please contact your specialty retailer or the returns management for any repairs [page 9].

6.1 Maintenance schedule

The following table provides an overview of all maintenance and servicing work that you must carry out permanently or at regular intervals.

Interval	Measures
Regularly, as needed	• Cleaning the device [page 42]
As needed / every 6 months	• Charging the battery [page 43]
Every 12 months	• Calibrating the device [page 44]

Table 17: Maintenance schedule

6.2 Making the device free of voltage

If you want to open the battery compartment for maintenance work, make sure first that the device is free of voltage.

Procedure

1. Remove the device from the measuring point.
2. Disconnect the safety measuring lines from the device.
3. Switch off the device.

6.3 Cleaning the device

Clean the device regularly and as the need arises. Make sure that the battery compartment and the battery contacts are not contaminated by leaking battery electrolyte.

Requirements

- A clean and dry cloth or special cleaning cloth
- Voltage-free device [page 42]

NOTICE

Wrong cleaning agents

Using the wrong cleaning agents can damage the device.

- Do not use any solvents, abrasives or polishing agents.

Procedure

1. Clean the exterior of the device with a clean and dry cloth or a special cleaning cloth.
2. Check the battery compartment. To open and close the battery compartment, follow the procedure given in the chapter “Replacing the batteries”.
3. In case of electrolyte contamination or white deposits in the area of the battery or the battery compartment, clean the batteries and these areas by means of a clean and dry cloth. Replace the batteries, if necessary.

6.4 Replacing or charging the battery

Charge the battery completely before using the device for the first time and as needed. Only use the PV 125 / PV 225 charging base (item no.: 11005060) included in the scope of delivery to charge the battery.

States of charge:

The charging base indicates the state of charge via a LED lighting in red/green.

- Flashing red and green alternately: Power supply is available, but no battery is connected.
- Flashing red: The battery is charging. The state of charge is below 33 %.
- Flashing red and green simultaneously: The battery is charging. The state of charge is between 33 % and 66 %.
- Flashing green: The battery is charging. The state of charge is between 66 % and 100 %.
- Lighting green constantly: The battery is fully charged.

Requirements

- Battery included in the scope of delivery, undamaged
- Included charging base PV 125 / PV 225 with USB-C jack
- Power supply unit with USB-C connector (Please observe the technical data on the bottom of the charging base.)
- Suitable slotted screwdriver
- Make sure that there is no flammable material within 2 metres of the charging base during the charging process.

Procedure

1. Unscrew the screw of the battery compartment on the rear of the device.
2. Remove the battery compartment cover.
3. Place one hand over the battery and turn the device over. The battery falls into your hand.
4. Connect the power supply unit to the charging base and to the mains by means of the USB-C connector.

5. Insert the battery into the charging base so that the contacts of the battery and those of the charging base are in contact. The LED indicates that the battery is charging.
6. When the charging process is completed, remove the battery.
7. Insert the battery into the device so that the contacts of the battery and those of the device are in contact.
8. Place the battery compartment cover onto the compartment.
9. Screw the battery compartment cover tight onto the device.

6.5 Calibrating the device

Benning guarantees compliance with this technical and accuracy specifications stated in this operating manual for the first 12 months after the delivery date.

To maintain accuracy of the measuring results, make sure that the device is recalibrated in annual intervals by the BENNING Service [page 9].

As part of a calibration, the device is provided with the latest firmware update and thus always remains up to date.

http://calibration.benning.de

6.6 Updating the firmware

You can only use the full functionality of the BTEC app with the latest device firmware.

Requirements

- Device with outdated firmware
- Connection to the BENNING Test Equipment Cloud (BTEC) via one of the following options:
  - Mobile device with installed BTEC app (Android or iOS) and connection to the Internet
  - Bluetooth-enabled Windows PC or Apple Mac with Chrome web browser installed and connection to the Internet

Procedure

1. Connect the device to a mobile device or Bluetooth-enabled Windows PC or Apple Mac.
2. Open the BTEC app or http://btec.benning.de.

   The device reports its currently installed firmware version.

   If a more recent firmware is available, you will be prompted to accept the latest firmware and start the transfer.
3. Accept it and start the transfer.

   The firmware update starts. Once the update is complete, the device restarts.
4. Press the “About” function key to see the current firmware version.

7 Technical data

Protection class	II (double or reinforced insulation)
Contamination level	2
Protection category (DIN VDE 0470-1, IEC / EN 60529)	IP 40 1st digit: 4 = protection against access to dangerous parts and protection against solid impurities (diameter >1.0 mm) 2nd digit: 0 = no protection against water
Measuring category	• CAT III 1 500 V-DC to earth, • CAT III 300 V-AC to earth
Housing dimensions (length x width x height)	265 mm x 115 mm x 78 mm
Weight (batteries included)	approx. 1 kg
Battery type	Rechargeable lithium-ion battery 11.55 V, 2 930 mAh
Digital display	3.5” colour display (480 x 320 pixels)
Electromagnetic compatibility (EMC)	IEC / DIN EN 61326
Operating duration	Short-term use (no continuous operation)
Max. barometric altitude	2 000 m
Operating temperature	+5 … +40 °C (do not permanently expose the device to sunlight)
Relative air humidity	Dry, non-condensing
Operating conditions	To be used inside or outside buildings, both in dry environments
Storage (remove the battery from the device)	
Ambient temperature	-25 … 65 °C (do not permanently expose the device to sunlight)
Relative air humidity	Dry, non-condensing
4 mm safety measuring lines	
Standard	IEC / DIN EN 61010-031 (VDE 0411-031)
Measuring category (only applies to the safety measuring lines, additionally observe the limitations of the device)	• CAT IV 1 000 V to earth
Max. rated current	12 A
Length	1.5 m
PV safety measuring lines	
Measuring category (only applies to the safety measuring lines, additionally observe the limitations of the device)	• CAT III 1 500 V to earth
Max. rated current	36 A
Length	1.1 m

Table 18: Technical data

8 Disposal and environmental protection

	At the end of product life, dispose of the unserviceable device and the batteries via appropriate collecting facilities provided in your community.

9 Appendix

9.1 Troubleshooting

Message	Displayed in	Possible corrective measure
There is an external voltage. Please remove all external sources.	Continuity	• Disconnect the external voltage source from the measured circuit. • Repeat the measurement.
There is an external voltage. Please remove all external sources.	String Test / Riso	• Check the connections of the measured circuit. • Repeat the measurement. • Do not exceed the measuring range. • Check whether the frame of the panel is correctly earthed.
Measurement circuit Error 1! Please retry test. If the problem persists, please contact the BENNING Service.	String Test	• Check the connections of the measured circuit. • Repeat the measurement. • Do not exceed the measuring range. If the problem persists, please contact the BENNING Service.
Measurement circuit Error 2! Please retry test. If the problem persists, please contact the BENNING Service.	String Test	• Check the connections of the measured circuit. • Repeat the measurement. • Do not exceed the measuring range. If the problem persists, please contact the BENNING Service.
Fuse error! Please contact the BENNING Service.	String Test	• The internal fuse is defective. Please contact the BENNING Service.
High temperature, please allow to cool.	String Test	• Disconnect the device from the mains. • Let it cool down before carrying out further measurements.
Internal error. If the problem persists, please contact the BENNING Service.	General / Continuity	• Switch the device off and on again. • If the problem persists, please contact the BENNING Service.

Table 19: Possible error messages and corrective measures

For more error messages and corrective measures, please refer to: https://tms.benning.de/pv-info

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