12.) Radio connection to the BENNING SUN 2

The BENNING PV 2 is able to receive the measured values (insolation, PV module / ambient temperature and date / time stamp) of the optional BENNING SUN 2 (part no. 050420) via radio connection.

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Typical radio range in open space: approx. 30 m

Coupling with BENNING SUN 2

- 1. Remove all electronic devices in direct vicinity
- 2. Switch the BENNING PV 2 and the BENNING SUN 2 off.
- 3. Press and hold the two ON/OFF keys of the BENNING SUN 2.
- 4. Press and simultaneously hold the ()-key () and the)-key () of the BENNING PV 2.
- The BENNING PV 2 indicates the successful coupling by means of an acoustic signal and by displaying the serial no. of the BENNING SUN 2
- 6. The "W/m2" symbol is shown on the LC display 1 of the BENNING PV 2.

Decoupling from BENNING SUN 2

- 1. Remove all electronic devices in direct vicinity.
- 2. Switch the BENNING PV 2 off.
- Press and hold the B-key and the -key for the BENNING PV 2 for approx. 10 seconds.
- The BENNING PV 2 indicates the decoupling from the BENNING SUN 2 by means of an acoustic signal and by clearing the LC display.
- 5. The " R_{PF}/Ω " symbol is shown on the LC display **1** of the BENNING PV 2.

Activating/deactivating the radio transmission of the BENNING SUN 2

- 1. Couple the BENNING PV 2 with the BENNING SUN 2.
- The BENNING PV 2 receives the measured values as soon as the insolation (W/m²) is shown on the LC display 1.
- AUTO measurement (modes ① ③) additional stores the temperature values and the date/time stamp of the BENNING SUN 2.
- 5. If the BENNING PV 2 is outside the radio range of the BENNING SUN 2, the "W/ m²" on the LC display ① starts flashing. Moreover, "____" is shown on the LC display, if the measured insolation value is outside the measuring range.

Note:

If the BENNING PV 2 does not receive any radio signal from the BENNING SUN 2, the display indications are stored with the date/time stamp of the BENNING PV 2.

13. Representing the I-V characteristic via the "BENNING PV Link" app Requirements: NFC-enabled Android device

The app allows the user to represent and to compare the measured I-V characteristic and the power characteristic with the nominal module data of the manufacturer under STC conditions.

Please read the detailed operating manual of the BENNING PV 2 and of the "BENNING PV Link" first (http://tms.benning.de/pv2).

- 1. The NFC chip required for this functionality is located under the NFC logo on the top of the BENNING PV 2 housing.
- Upon completion of each test procedure (modes (2 + 3)) as well as after calling a storage location via the (2)-key (2) and pressing the (1)-key (2), the I-V characteristic is written to the NFC chip.
- The I-V characteristic can be read and represented via an Android device with NFC functionality.



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14. Measuring ranges and limiting values

Function	Range
R _{PE} /V	0.05 Ω - 199 Ω/30 V - 440 V AC/DC
R _{ISO} (2-pin)	0.05 ΜΩ - 300 ΜΩ
Vo/c	5 V - 1000 V DC
ls/c	0.5 A - 20 A DC
R _{ISO} (AUTO measurement)	0.2 ΜΩ - 200 ΜΩ
	0.1 A - 40 A AC/DC
ISO test voltage	Limiting value of insulating resistance
250 V	0.5 ΜΩ
500 V/ 1000 V	1.0 MΩ

15. Setting the date and time

- 1. Turn off the BENNING PV 2.
- 2. Press and hold the (2)-key (3) and then press simultaneously the (2)-key (3) and the (2)-key (3) of BENNING PV 2.
- The date format and time format is shown as follows: MM.DD = month (1-12). Day (1-31) YYYY = year HH.mm = hours (0-23).minutes (0-59) SS = seconds (0-59)
- 4. Press the (R_{re}) -key 2 to select a date field and time field
- 5. A blinking field shows that this field can be set.
- With the D-key D and the -key O, the value increases or decreases. With each change, the second field is set to zero.
- 7. Turn off the device to save the setting.

Note:

If the BENNING PV 2 has established a radio connection to the BENNING SUN 2, the date/ time of the BENNING PV 2 will be synchronized automatically after 10 seconds to the date/ time of the BENNING SUN 2, if the device detects a deviation of more than 1 minute. BENNING SUN 2 (master) \rightarrow BENNING PV 2 (slave).

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16. Error codes	
Error code	Remedy
FUSE	The internal fuse has blown. Refer to the operating manual for details.
ноғ	The electronic components of the BENNING PV 2 have reached the maximum admissible tempera- ture. Disconnect the BENNING PV 2 from the ob- ject to be measured and let it cool down.
H ,SC	The DC short-circuit current has the maximum va- lue of 15 A. The measurement has been stopped.
л °ОС	The DC open circuit voltage has exceeded the maximum value of 1000 V. The measurement has been stopped.
> [].[] [] ^{kW}	The DC power has exceeded the maximum value of 10 kW. Measurement has been cancelled.
d IS- CONN ECE	Immediately disconnect the BENNING PV 2 from the PV generator! Please return it to an authorized service center (see the detailed operating manual for the address).
do NOE USE Er 12	Please return the BENNING PV 2 to an authorized service center (see the detailed operating manual for the address).
HOFL	Please return the BENNING PV 2 to an authorized service center (see the detailed operating manual for the address).
FEE	Please return the BENNING PV 2 to an authorized service center (see the detailed operating manual for the address).
r L 1,2,3,4	Please return the BENNING PV 2 to an authorized service center (see the detailed operating manual for the address).
Er 1,2 _{etc.}	Please return the BENNING PV 2 to an authorized service center (see the detailed operating manual for the address).
CAL	Please return the BENNING PV 2 to an authorized service center.
STORE	Storage has failed. Please store the measured va- lues again to the next storage location available.
	Storage to the NFC chip has failed. Please remove the NFC-enabled device from the BENNING PV 2.

Other error codes see detailed operating manual (http://tms.benning.de/pv2).

17. Optional accessories

PC software BENNING SOLAR Manager	(part no. 050423
Temperature sensor with suction cup for BENNING SUN 2	(part no. 050424
PV module holder for BENNING SUN 2	(part no. 050425
Current clamp adapters BENNING CC 3	(part no. 044038
Measuring lead BENNING TA 5, length 40 m	(part no. 044039

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BENNING PV 2

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Short Instruction	IS
BENNING PV 2	
Refore using the BENNING PV 2 please r	ead the detailed operating
The BENNING PV 2 should only be use sonnel.	d by suitably trained per-
The connection to the PV generator is cordance with the connection figure of th Disconnect not required tests leads from	made exclusively in ac- ne operating manual. the BENNING PV 2.
Before the measurement disconnected the inverter!The PV string under test must open-circuit voltage of 1000 V, the maxim 15 A and the maximum DC power (P = Uoc The measurements are to be carried out on the time that all PV strings are isolated from Only test a single PV string, never test mu parallel connections! High levels of capacita test can cause high currents to flow and n ment. The PV generator may not contain any power a short circuit, power optimisers can generator.	PV generator from the PV not exceed the maximum num short-circuit current of x lsc) of 10 kW. the individual PV string! as and isolating devices are n each other. Itiple strings and beware of ance within the circuit under nay damage the test instru- er optimisers. In the event of rate transient current peaks tt-circuit current (lsc) of the
Disconnect the BENNING PV 2 from the the test.	test sample directly after
Do not touch the measuring probes! Du measurements, high electric currents measuring probes.	ring insulating resistance might be applied to the
Do not touch any metal parts of the tes ment.	st object during measure-
The PV generator must be isolated from the Neither the positive nor the negative pole be earthed!	the electric power supply! e of the PV generator must
Via the 4 mm test leads, voltage measu circuits are possible. Via the 4 mm test so must be used only in electric circuits o with max. 300 V AC/DC for phase-to-eart please disconnect the PV 2 PV measurin sockets before measuring.	rements on mains supply ockets, the BENNING PV 2 of overvoltage category III h measurements. For this ng leads from the PV test
Before starting the unit, always check it for use a damaged BENNING PV 2!	or signs of damage. Do not
▲ Only use measuring leads, which BENNING PV 2.	are supplied with the
The BENNING PV 2 is intended for making ambient conditions only.	g measurements under dry
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2. Switching the device ON/OFF

Press the (R_)-key (1) and the (m)-key (5) simultaneously to switch the device ON or OFF. Without pressing a key, the device switches OFF automatically after approx. 1 minute (APO, Auto Power-Off). The switch-off time can be set within a range from 1 min. to 10 min. (see operating manual on http://tms.benning.de/pv2).

3. Device description

LC Display

- 2 (Rep key, protective conductor test
- 3 (Auto)-key, automatic test procedure
- $(\underline{A}, \underline{B}, \underline{B$
- **6** (model)-key, selecting the test procedures
- (a)-key, null balance of the measuring line
- (V_{so}) -key, selecting the ISO testing voltage
- **(a)** (b)-key, calling measured values
- General Action of LC display
- (I)-Taste, storing measured values
- PV test socket (black)
- G 4 mm test socket (black)
- + 4 mm test socket (red)



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4. AUTO measurement of the PV generator

- 1. Carefully read and understand all safety notes under point 1. "Important information"
- 2. Connect the BENNING PV 2 to the PV generator as shown, by means of the enclosed PV measuring leads and the red 4 mm test lead.
- 3. The open-circuit voltage (Vo/c) is automatically displayed.
- 4. In case of reversed polarity of the DC voltage, the symbol $^{+}\times^{+}$ is displayed 1 and the measurement will be blocked.
- 5. Press the Model key 5 to select the desired test procedure (modes (1) (4)): (1) Measuring Vo/c. Is/c and M Ω

(2) Measuring the I-V characteristic with Vmpp, Impp and FF (filling factor) ③ Measuring ① + ②

④ Measuring via AC/DC current clamp

- 6. Press the (v)-key () to select an ISO testing voltage of 250 V. 500 V or 1.000 V.
- 7. Press the Auto-key (3) to start the test procedure.
- 8. As soon as the test procedure is completed. "Store?" will be indicated on the LC display 1.
- 9. Press the ()-key () to store the measured values.





the inverter before testing!

Only test a single PV string, never test multiple strings and beware of parallel connections! High levels of capacitance within the circuit under test can cause high currents to flow and may damage the test instrument.

The PV generator may not contain any power optimisers!

Note:

The red 4 mm measuring lead is required for the insulation resistance measurement. Measurement of the I-V characteristic requires previous coupling to the BENNING SUN 2.

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- **BENNING PV 2**

- 5. Null balance of the measuring leads, resistance (Rpc)
- 1. Connect the measuring leads to the red and black 4 mm test sockets of the BENNING PV 2.
- 2. Short-circuit the probe tips via the alligator clips.
- 3. Press and hold the ()-key 6 until an acoustic signal sounds and the bol is displayed 1.
- 4. The Null-value is stored when unit is switched off.
- 5. To disable, press ()-key 6 until the -symbol is removed from LC display 1.



- 6. Protective conductor resistance (R_{PF}) 1. Connect the 4 mm measuring leads as shown.
- 2. To make a single measurement (2 sec.), press and release the (R_{H}) -key **2**.
- 3. To make a continuous measurement, press and hold the (Ref)-key 2 until the symbol 🔒 is displayed 1 continuously.
- 4. Press the (Ref)-key 2 to terminate the continuous measurement.
- 5. Press the ()-key () to store the measured values.



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7. Insulating resistance (RISO, 2-pin)

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- 1. Connect the 4 mm measuring leads as shown in the figure.
- 2. Press the (V_)-key 1 to select an ISO testing voltage of 250 V. 500 V or 1.000 V.
- 3. For single measurement (2 sec.), press and release the (Ray-key 4). For continuous measurement, press and hold the R. + key I for several seconds until the f symbol is shown on the LC display 1.
- 4. Press the R-key 4 to terminate the continuous measurement.
- 5. Press the ()-key () to store the measured values.



Option: 40 m measuring leads BENNING TA 5 part no. 044039

8. AC/DC current measurement

- 1. Disconnect all measuring leads from the BENNING PV 2.
- 2. Connect the BENNING CC 3 (option) current clamp adapter to the 4 mm test sockets
- 3. Select the 40 A range on the BENNING CC 3.
- 4. Press the null balance key (ZERO) of the BENNING CC 3 for approx. 2 seconds.

BENNING PV 2

- 5. Press the wood-key 6 to select the desired mode 4 of the BENNING PV 2. The symbol is shown on the LC display ①.
- 6. The AC/DC current can be measured in single-wire live conductor.
- 7. Press the ()-key () to store the measured values.







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9. AC/DC voltage measurement

1. Disconnect the PV measuring leads from the BENNING PV 2.

2. Connect the red and black safety measuring lead as pictured.

3. The BENNING PV 2 automatically measures the AC/DC voltage at the measuring probes.

4. The polarity of the DC voltage is displayed by "+/-". In case of AC voltage, "+/-" will be displayed alternately.

5. Press the ()-key () to store the measured values.



10. Measured value memory (999 display screens)

Store	Store all measurements currently on the LC display. In the RE-CALL mode, the measuring results are called in reverse order.
D-Recall	Recall the stored measured values on the LC display. Press and hold to send the measured value memory to the USB port.
1 + 1	Clear all results from memory.
🗊 +Display	Switch-over of the LC display in the I-V characteristics mode from Vo/c, Is/c to Vmpp, Impp.

11. Downloading the measured value memory to the PC

1. Install the BENNING SOLAR data logger and driver from http://tms.benning.de/ nv2

2. Disconnect all measuring leads from the BENNING PV 2.

3. Connect the BENNING PV 2 to your PC by means of the USB connecting cable. 4. Start the PC software, select the COM port and click "Download".

5. Switch on the BENNING PV 2, press the (2)-key (3) and hold the (2)-key (3) again for approx. 2 seconds to start the download.

6. Open the measured value file in the CSV format via MS Excel®.

Note:

The optional PC software BENNING SOLAR Manager (part no. 050423) allows documentation according to DIN EN 62446 (VDE 0126-23) as well as representation of the I-V characteristic according to DIN EN 61829 (VDE 0126-24).