BENNING

Operating manual

Translation of the German original version



BENNING CM 2-1

5191 / 11/2021 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.

Manufacturer and holder of rights

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Disclaimer

The contents of the documentation has been checked to ensure that it corresponds to the hardware and software described. Nevertheless, deviations cannot be ruled out, so Benning cannot guarantee complete correspondence. The contents of this documentation are checked at regular intervals, and any corrections that are needed are contained in the versions that follow.

General non-discrimination

Benning is aware of the importance of language with regard to the equality of men and women, and endeavours 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 TRUE RMS digital current clamp multimeter BENNING CM 2-1 described here (in the following only referred to as “device”) is intended for testing in circuits with a nominal voltage up to a maximum of 600 V-AC or 600 V-DC. The device enables you to perform the following tests and measurements:

- DC and AC voltage measurement
- DC and AC measurement
- Resistance measurement
- Diode and continuity test
- Capacitance measurement
- Frequency measurement

Further information

http://tms.benning.de/cm2-1

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 General notes

Target group

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

- Qualified electricians and electrotechnically trained 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 provide 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 trade marks that are used are the property of their respective owners, even if they are not separately marked as such.

1.2 History

Release number	Amendments
07/2021	• Initial release
11/2021	• Revision of the operating manual

Table 1: History

1.3 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 standards and has left the factory in perfectly safe condition.

- IEC / DIN EN 61010-1 (VDE 0411-1)
- IEC / DIN EN 61010-2-032 (VDE 0411-2-032)
- IEC / DIN EN 61010-2-033 (VDE 0411-2-033)
- IEC / DIN EN 61010-031 (VDE 0411-031)

2.3 Symbols used

Symbols on the device

Symbol	Meaning
	Application around and removal from hazardous live conductors is permitted.
	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 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 UK directives.
	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.
	(DC) direct voltage or direct current
	(AC) alternating voltage or alternating current
	Earth (voltage to earth)

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.

In particular, 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 damage is due to force majeure.
- If any prescribed services are not performed regularly or not on time according to manufacturer 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 may only be used in a technically perfect and safe condition. Always check the device for damages before using it.
- Make sure the personnel using the device is qualified for the respective task.
- Observe relevant regulations on occupational safety and health as well as those on environmental protection.
- The device may only be used in dry environments.
- Use the device only in electric circuits of overvoltage category III with a conductor for a maximum of 600 V or overvoltage category IV with a conductor for a maximum of 300 V to earth.
- Use suitable (approved) safety measuring lines. For measurements in electric circuits of overvoltage category III or IV, the protruding conductive part of a contact tip of the safety measuring line must not be longer than 4 mm. Before measuring, attach the enclosed protective caps onto the contact tips (marked with CAT III and CAT IV).
- In order to detect a dangerous voltage and to prevent any danger, always measure a present voltage first without low-pass filter (without high-frequency suppression “HFR”).
- In order to prevent danger due to incorrect measurements, replace discharged batteries immediately.



⚠ 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.
- 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.
- Attach the protective caps to the contact tips of the safety measuring lines (circuits of overvoltage category CAT III or IV).



⚠ 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 TRUE RMS digital current clamp multimeter BENNING CM 2-1
- Safety measuring lines (item no.: 044145):
  - 1 x safety measuring line (red, l = 1.4 m)
  - 1 x safety measuring line (black, l = 1.4 m)
- 1 x compact protective pouch
- 2 x 1.5 V micro batteries (AAA / IEC LR03)
- 1 x operating manual

Optional accessories

- Flexible AC current transformer BENNING CFlex 1 (item no.: 044068)
  AC range: 30 A / 300 A / 3 000 A



Figure 1: BENNING CFlex 1

- Set of safety measuring lines BENNING TA 1 (item no.: 044124)
  Ø 4 mm alligator clips, 2-piece, red / black, professional version, CAT III 1 000 V, 36 A



Figure 2: BENNING TA 1

- Set of safety measuring lines BENNING TA 2 (item no.: 044125)

  Set of Ø 4 mm measuring lines, 6-piece, red / black, professional version, consisting of:

  – Measuring lines (silicone) (CAT III 1 000 V)
  – Test probes (4 mm measuring probe, CAT II 1 000 V)
  – Alligator clips (CAT III 1 000 V)



Figure 3: BENNING TA 2

- Set of safety measuring lines BENNING TA 3 (item no.: 044126)

  Set of Ø 4 mm measuring lines, 8-piece, red / black, professional version, CAT III 1 000 V, consisting of:

  – Measuring lines (silicone)
  – Test probes (slender measuring probe)
  – Grabber clips
  – Alligator clips



Figure 4: BENNING TA 3

- Set of Ø 4 mm safety measuring lines with 2 mm measuring probe (item no.: 044146)

  Ø 4 mm measuring lines, 2-piece, red / black, L = 1.40 m, with 2 mm measuring probe, CAT IV 600 V / CAT III 1 000 V (with protective caps), CAT II 1 000 V (without protective caps)



Figure 5: Ø 4 mm measuring lines with 2 mm measuring probe

4 Device description

4.1 Device structure



Figure 6: BENNING CM 2-1 device structure

1	Measuring clamp (for clamping the conductor)	2	“AC HFR / DCA ZERO” key
3	“HOLD / MIN MAX” key	4	Rotary switch
5	Digital display	6	“+” jack
7	COM jack	8	Opening lever
9	Current clamp bulge (protection against contact with conductor)		

Rear panel of the device

- Battery compartment with battery compartment cover
  The device is powered by two 1.5 V micro batteries (AAA / IEC LR03).
- 2 labels on the battery compartment cover (notes and information about the device)
- Serial number (label)

Rotary switch

You can set the desired test or measurement by means of the rotary switch.

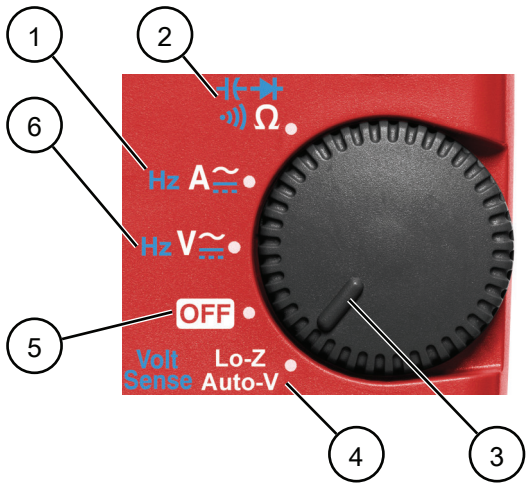


Figure 7: Rotary switch

1	Current or frequency measurement	2	Resistance, capacitance measurement, continuity or diode testing
3	Setting of the rotary switch	4	Voltage measurement or voltage indicator
5	Device switched off	6	Voltage or frequency measurement

Digital display

The digital display is divided into different sections:

- Display of the currently set function and unit
- Display range: 4-digit liquid crystal display (LCD) with a font size of 14 mm and decimal points. The highest display value is 4 000 digits.
- Battery status: Indicates the state of charge of the batteries (max. 3 segments). The batteries are discharged as soon as all segments have disappeared and the symbol is flashing. When switching it on, the device additionally displays the battery status: “FULL” (full), “HALF” (half) or “Lo” (low).
- Polarity display (automatic): Indicates a polarity contrary to the jack definition with “-”.
- Dangerous contact voltage (symbol is flashing)

The nominal measuring rate of the device is 2 measurements per second for the digital display. By means of a light sensor, the display illumination switches on automatically in dark lighting conditions.



Figure 8: Digital display

1	Display of functions and units	2	Display range
3	Battery status	4	Polarity
5	Dangerous contact voltage		

4.2 Functions

Use the rotary switch to switch the device on (desired measuring function) or off (“OFF”).

The device confirms each operation of keys and the rotary switch with an acoustic signal. Invalid keystrokes are confirmed with a double beep. The device switches off automatically after approx. 20 minutes (APO, Auto-Power-Off). To switch the device back on, first set the rotary switch to switch position “OFF” and then set the desired measuring function.

4.2.1 “AC HFR / DCA ZERO” key

The “AC HFR / DCA ZERO” key has three functions.

“MODE” function

Press the “AC HFR / DCA ZERO” key to select the second, third or fourth function of the respective rotary switch position.

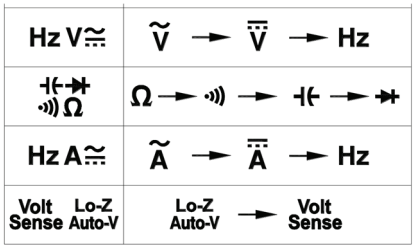


Figure 9: “MODE” function

“HFR (AC)” function (low-pass filter)

The “HFR (AC)” function is intended to connect a low-pass filter (high-frequency suppression) during AC current or AC voltage measurement. With this low-pass filter, it is possible to filter out high-frequency pulses, e. g. on pulsed motor drives.

Press and hold the “AC HFR / DCA ZERO” key for approx. 2 s to enable or disable the function. With the function being enabled, the “HFR” symbol appears on the digital display.

The limiting frequency (-3 dB) of the filter is fg = 800 Hz. When reaching the limiting frequency fg, the displayed value is lower by a factor of 0.707 than the actual value without filter.

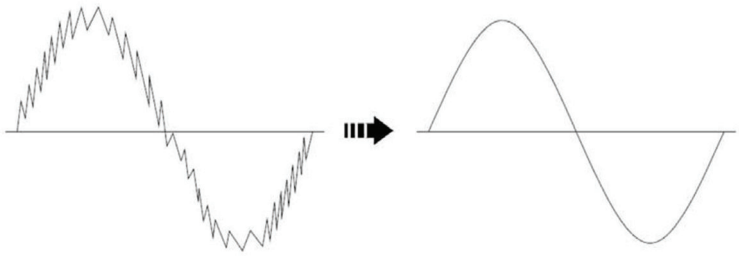
Without low-pass filter	With low-pass filter
	

Table 4: Low-pass filter

“ZERO (DC)” function

The “ZERO (DC)” function is intended to carry out a null balance before making direct current (DC) measurements.

To carry out the null balance, press and hold the “AC HFR / DCA ZERO” key for approx. 2 s until the “Δ” symbol appears on the digital display. The device must not be in the vicinity of a live conductor.

4.2.2 “HOLD / MIN MAX” key

The “HOLD / MIN MAX” key has two functions.

“HOLD” function

The “HOLD” function is intended to hold the currently measured value.

Press the “HOLD / MIN MAX” key, to hold the currently measured value and the “H” symbol appears on the digital display. Press the “HOLD / MIN MAX” key again to discard the held measured value is discarded and the currently measured value will be displayed again.

“MIN MAX” function

The “MIN MAX” function is intended to determine and store the minimum and maximum measured value during current or voltage measurement (DC and AC).

Press and hold the “HOLD / MIN MAX” key for approx. 2 s to enable or disable the function. With the function being enabled, the “MaxMin”, “Max” or “Min” symbol appears on the digital display. Press the “HOLD / MIN MAX” key to toggle the display.

- MaxMin: Currently measured value
- Max: Maximum stored measured value
- Min: Minimum stored measured value

4.2.3 Further setting options

The device offers further setting options. To change a setting, press one of the following keys and simultaneously set any measuring function from the “OFF” position of the rotary switch.

- “AC HFR / DCA ZERO” key: Enables or disables the light sensor for automatic display illumination (display “ON” or “OFF”)
- “HOLD / MIN MAX” key: Shows all symbols of the digital display

4.3 Measuring ranges

The device is provided with an automatic switch-over of the measuring range. For this reason, a default setting is not required.

If a measuring range is exceeded, this is indicated by “0L” or “-0L” and, depending on the measuring function, additionally by an acoustic warning. Please note that there will be no indication and warning in case of overload. In case of dangerous contact voltages (from 60 V-DC or 30 V-AC RMS on), the flashing symbol "⚡“ is additionally displayed.

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 stated measuring accuracy is specified for 1 % to 100 % of the final measuring range value and applies at a temperature of 23 °C ±5 °C and a relative air humidity lower than 80 %. In case of deviating temperatures, observe the temperature coefficient by adding the following value to the specified measuring accuracy:

0.2 [1/°C] x specified measuring accuracy x difference to reference temperature range [°C]

Additional specifications for AC functions

The measured value is obtained and displayed as real r.m.s. value (TRUE RMS). For non-sinusoidal curves, the accuracy of the displayed value decreases. Thus, an additional error results for the following crest factors:

- Crest factor from 1.0 to 2.0: +1.0 %
- Crest factor from 2.0 to 2.5: +2.5 %
- Crest factor from 2.5 to 3.0: +4.0 %

Maximum crest factor of the measuring signal:

- 3.0 @ 2 000 digits
- 1.5 @ 4 000 digits

Note the following additional features:

- Measured values <10 digits are set to 0 on the digital display.
- Square-wave signals are not specified.
- Positioning error of the conductor within the measuring clamp: ± 1 % of the measured value

“HFR (AC)” function (low-pass filter)

Please observe the following features for the “HFR (AC)” function (low-pass filter):

- Additional error for AC current or voltage measurements:
  - Frequency range 15 ... 60 Hz: ±4 % with regard to the specified measuring accuracy
  - Frequency range >60 Hz: Not specified
- Limiting frequency fg (-3 dB): 800 Hz

4.3.1 Voltage ranges

AC voltage ranges (V-AC)

Overload protection: 600 V-AC / V-DC

Measuring range	Resolution	Measuring accuracy
400 mV	0.1 mV	±(1.5 % + 5 digits)
4 V	0.001 V	±(1.5 % + 2 digits)
40 V	0.01 V	
400 V	0.1 V	
600 V	1 V	

Table 5: AC voltage ranges (V-AC)

- Frequency range:
  - Measuring range 40 … 600 V: 15 Hz … 1 kHz
  - Measuring range 400 mV … 4 V: 15 … 500 Hz
- Input resistance: 10 MΩ II < 100 pF

DC voltage ranges (V-DC)

Overload protection: 600 V-AC / V-DC

Measuring range	Resolution	Measuring accuracy
400 mV	0.1 mV	±(0.5 % + 5 digits)
4 V	0.001 V	±(0.5 % + 2 digits)
40 V	0.01 V	
400 V	0.1 V	
600 V	1 V	

Table 6: DC voltage ranges (V-DC)

- Input resistance: 10 MΩ

Voltage ranges (LoZ, AutoV)

Overload protection: 600 V-AC / V-DC

Measuring range	Resolution	Measuring accuracy
600 V	1 V	±(2.0 % + 2 digits)

Table 7: Voltage ranges (LoZ, AutoV)

- Frequency range: 15 Hz … 1 kHz
- Input resistance: <4 kΩ

4.3.2 Current ranges

AC ranges (A-AC)

Overload protection: 400 A-AC / A-DC

Measuring range	Resolution	Measuring accuracy	
		15 … 500 Hz	0.5 … 1 kHz
40 A	0.01 A	±(2.5 % + 5 digits)	±(3.5 % + 5 digits)
400 A	0.1 A		

Table 8: AC ranges (A-AC)

- Frequency range: 15 Hz … 1 kHz

DC ranges (A-DC)

Overload protection: 400 A-AC / A-DC

Measuring range	Resolution	Measuring accuracy
40 A	0.01 A	±(2.5 % + 5 digits)
400 A	0.1 A	

Table 9: DC ranges (A-DC)

4.3.3 Resistance ranges

Overload protection: 600 V-AC / V-DC

Measuring range	Resolution	Measuring accuracy[1)]
400 Ω	0.1 Ω	±(1.0 % + 5 digits)
4 kΩ	0.001 kΩ	
40 kΩ	0.01 kΩ	
400 kΩ	0.1 kΩ	
4 MΩ	0.001 MΩ	
40 MΩ	0.01 MΩ	±(1.5 % + 5 digits)

Table 10: Resistance ranges (Ω)

1) Before measuring, check for a possible offset by short-circuiting the measuring lines and subtract it from the measured value.

- Measured values >10 MΩ might vary by 50 digits.

4.3.4 Continuity test

Overload protection: 600 V-AC / V-DC

Measuring range	Resolution	Measuring accuracy
400 Ω	0.1 Ω	±(1.0 % + 5 digits)

Table 11: Continuity test

- The integrated buzzer sounds at a resistance lower than 20 … 200 Ω.
- Buzzer response time: <500 µs

4.3.5 Diode test

Overload protection: 600 V-AC / V-DC

Measuring range	Resolution	Measuring accuracy
1.5 V	0.001 V	±(1.5 % + 5 digits)

Table 12: Diode test

- Open-circuit voltage: approx. 1.8 V

4.3.6 Capacitance ranges

Requirements: Discharge the capacitors and apply the safety measuring lines according to the marked polarity.

Overload protection: 600 V-AC / V-DC

Measuring range	Resolution	Measuring accuracy
1 µF	0.001 µF	±(2.0 % + 5 digits)
10 µF	0.01 µF	
100 µF	0.1 µF	
1 mF	0.001 mF	
10 mF	0.01 mF	

Table 13: Capacitance ranges (µF)

4.3.7 Frequency ranges

Overload protection: 600 V-AC / V-DC, 400 A-AC / A-DC

Measuring range	Resolution	Measuring accuracy
50 Hz	0.01 Hz	±(0.5 % + 5 digits)
500 Hz	0.1 Hz	
5 kHz	0.001 kHz	
50 kHz	0.01 Hz	

Table 14: Frequency ranges (Hz)

- Minimum sensitivity:
  - V-AC range 1 Hz … 10 kHz: >6 V_{eff}
  - V-AC range 10 … 50 kHz: >20 V_{eff}
  - A-AC range 1 Hz … 10 kHz: >6 A_{eff}
- Minimum frequency: 1 Hz

5 Operation

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

5.1 Requirements for tests and measurements

- Remove the device (safety measuring lines) from the measuring point before setting a switch position on the rotary switch of the device.
- Only use approved safety measuring lines [page 27].
- 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.
- Please observe the associated measuring ranges and measuring accuracies in chapter Measuring ranges [page 22] for carrying out the tests and measurements.



⚠ 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 of overvoltage category III with a conductor for a maximum of 600 V or of overvoltage category IV with a conductor for a maximum of 300 V to earth.

5.2 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 26].
- 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.
- Protective caps (depending on the overvoltage category)
- 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.
- 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.
- Attach the protective caps to the contact tips of the safety measuring lines (circuits of overvoltage category CAT III or IV).

Procedure

1. Connect the black safety measuring line to the COM jack of the device.
2. Connect the red safety measuring line to the “+” jack of the device.
3. Measurements or tests in circuits of overvoltage category III or IV: Attach the protective caps to the contact tips of the safety measuring lines.

5.3 Voltage or frequency measurement

Requirements

- Please observe the requirements for measuring [page 26].
- Approved safety measuring lines
- Voltage ranges [page 23] and frequency ranges [page 25]



Figure 10: AC voltage or frequency measurement



Figure 11: DC voltage measurement

Procedure

1. Set the rotary switch of the device to switch position “Hz V≅” or “Volt Sense / Lo-Z Auto-V”.
   – “Hz V≅”: Press the “AC HFR / DCA ZERO” key to set the desired measuring function (frequency, AC or DC voltage).
   – “Volt Sense / Lo-Z Auto-V”: The corresponding measuring function (AC or DC voltage) and the optimum measuring range are set automatically. The input resistance is reduced to approx. 3 kΩ in order to suppress inductive and capacitive voltages (reactive voltages).
2. Connect the safety measuring lines to the device [page 27].
3. Bring the safety measuring lines into contact with the measuring points and read the measured value on the digital display.

5.4 Current or frequency measurement

Requirements

- Please observe the requirements for measuring [page 26].
- Make sure that no voltage is applied to the jacks of the device (“COM” and “+”). Remove any connected safety measuring lines.
- Current ranges [page 24] and frequency ranges [page 25]



Figure 12: Current or frequency measurement

Procedure

1. Set the rotary switch of the device to switch position “Hz A⎓”.
2. Press the “AC HFR / DCA ZERO” key to set the desired measuring function (frequency, AC or DC).
3. For DC measurements: Press and hold the “AC HFR / DCA ZERO” key for approx. 2 s to switch the device into the initial mode by means of a null balance. The “Δ” symbol is shown on the digital display.
4. Operate the opening lever and clamp the single-wire live conductor centrally with the measuring clamp.
5. Read the measured value on the digital display.

5.5 Resistance measurement

Requirements

- Please observe the requirements for measuring [▷ page 26].
- Approved safety measuring lines
- Resistance ranges [▷ page 24]

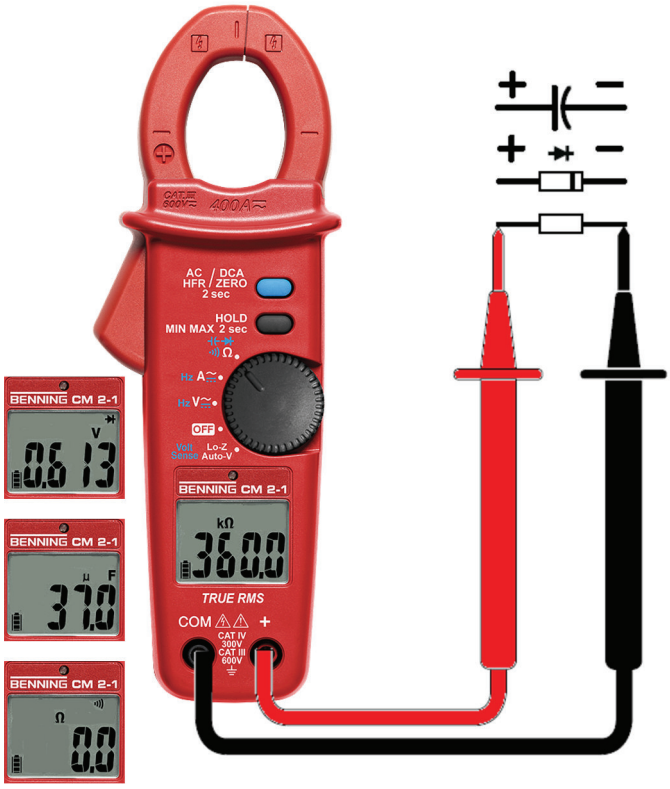


Figure 13: Resistance, capacitance measurement, continuity or diode testing

Procedure

1. Set the rotary switch of the device to switch position “”.

   The “Resistance measurement” function is set automatically (“Ω” is displayed, “” is hidden).
2. Connect the safety measuring lines to the device [▷ page 27].
3. Bring the safety measuring lines into contact with the measuring points and read the measured value on the digital display.

5.6 Continuity testing

Requirements

- Please observe the requirements for measuring [▷ page 26].
- Approved safety measuring lines
- Continuity test [▷ page 24]
- Please observe the figure for continuity testing. [▷ page 31]

Procedure

1. Set the rotary switch of the device to switch position “”.
2. Connect the safety measuring lines to the device [▷ page 27].
3. Press the “AC HFR / DCA ZERO” key to set the desired “Continuity test” function (“” symbol).
4. Bring the safety measuring lines into contact with the measuring points.

   When the buzzer sounds (acoustic signal), the line resistance between the COM jack and the “+” jack falls below the value of 20 to 200 Ω.

5.7 Capacitance measurement

Requirements

- Please observe the requirements for measuring [▷ page 26].
- Approved safety measuring lines
- Capacitance ranges [▷ page 25]



NOTICE

Capacitors not discharged

Measuring the capacitance at capacitors that are not fully discharged can damage the device.

- Discharge the capacitors completely before measuring the capacitance.
- Do not apply any voltage to the jacks of the device (“COM” and “+”) during the capacitance measurement.

- Please observe the figure for capacitance measurement [▷ page 31].

Procedure

1. Set the rotary switch of the device to switch position “”.
2. Connect the safety measuring lines to the device [▷ page 27].
3. Press the “AC HFR / DCA ZERO” key to set the desired “Capacitance measurement” function (“n” symbol).
4. Bring the safety measuring lines into contact with the discharged capacitor – observing correct polarity – and read the measured value on the digital display.

5.8 Diode testing

Requirements

- Please observe the requirements for measuring [▷ page 26].
- Approved safety measuring lines
- Diode test [▷ page 25]
- Please observe the figure for diode testing [▷ page 31].

Procedure

1. Set the rotary switch of the device to switch position “⏚”.
2. Connect the safety measuring lines to the device [▷ page 27].
3. Press the “AC HFR / DCA ZERO” key to set the desired “Diode test” function (“⏚” symbol).
4. Bring the safety measuring lines into contact with the measuring points and read the measured value on the digital display.
   – Standard Si diode applied in forward direction: A forward voltage from 0.4 to 0.8 V is displayed.

     “000”: indicates a short circuit inside the diode.

     “OL”: indicates an interruption inside the diode.
   – Diode applied in reverse direction: “OL” is displayed. In case of defective diodes, “000” or other values will be displayed.

5.9 Voltage indicator



⚠ WARNING

Incorrect use of the function

Danger to life or serious injury is possible due to contact with high electric voltage if the “Voltage indicator” function is used incorrectly.

- Please observe that a dangerous contact voltage might be applied even if it is not indicated by a visual or acoustic signal.
- Do not use the “Voltage indicator” function to test for the absence of voltage.

5.9.1 Non-contact phase testing

There is a detector located on the top of the device. This detector enables non-contact detection of alternating fields.

Requirements

- Please observe the requirements for measuring [page 26].
- Make sure that no voltage is applied to the jacks of the device (“COM” and “+”). Remove any connected safety measuring lines.



Figure 14: Non-contact phase testing

Procedure

1. Set the rotary switch of the device to switch position “Volt Sense / Lo-Z Auto-V”.
2. Press the “AC HFR / DCA ZERO” key to enable the “Voltage indicator” function.
   “EF” is shown on the digital display.
3. Place the top of the measuring clamp near the measuring point.
   If the symbols “⚡” and “EF” are flashing on the digital display, the phase of an earthed alternating voltage is applied to this measuring area.

Practical tip

Interruptions (cable breaks) in exposed cables – e. g. in cable reels, chains of light, etc. – can be traced from the feeding point (phase) to the point of interruption.

Functional range: ≥230 V

5.9.2 External conductor or phase testing

Requirements

- Please observe the requirements for measuring [page 26].
- Approved red safety measuring line
- Make sure that no voltage is applied to the COM jack of the device. Remove a connected black safety measuring line.

Procedure

1. Set the rotary switch of the device to switch position “Volt Sense / Lo-Z Auto-V”.
2. Connect the red safety measuring line to the “+” jack of the device [page 27].
3. Press the “AC HFR / DCA ZERO” key to enable the “Voltage indicator” function.
   “EF” is shown on the digital display.
4. Bring the safety measuring lines into contact with the measuring point (system part).
   If the symbols “⚡” and “EF” are flashing on the digital display, the phase of an earthed alternating voltage is applied to this measuring point.

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
As needed	• Replacing the batteries [page 38]
Every 12 months	• Calibrating the device [page 38]

Table 15: 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. Set the rotary switch of the device to switch position “OFF”.

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 36]



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” [page 38].
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 [page 38].

6.4 Replacing the batteries

The device is powered by two 1.5 V micro batteries (AAA / IEC LR03). Replace the batteries as soon as they are discharged.

Requirements

- Discharged batteries inside the device (all segments of the battery symbol on the digital display have disappeared and the battery symbol is flashing)
- 2 new 1.5 V micro batteries (AAA / IEC LR03)
- Voltage-free device [page 36]

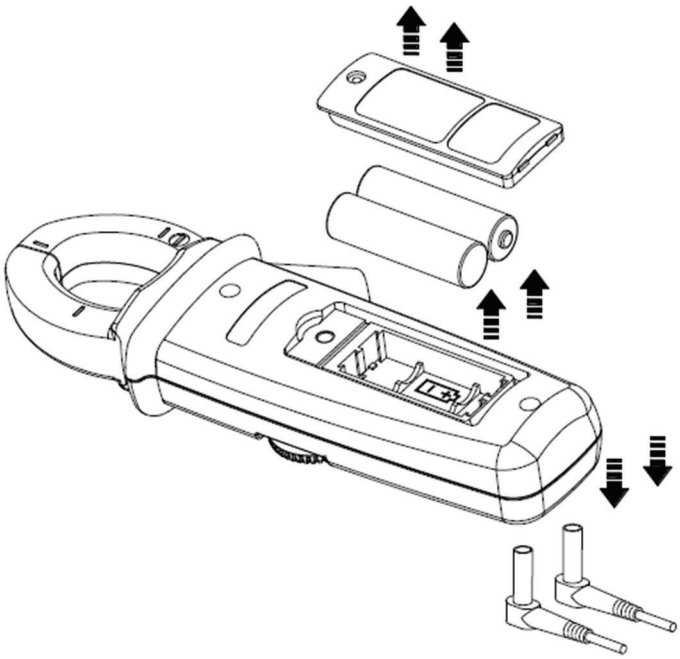


Figure 15: Battery replacement (exemplary)

Procedure

1. Place the device face down (onto an anti-slip surface).
2. Unscrew the screw of the battery compartment cover.
3. Lift the battery compartment cover off the device.
4. Remove the discharged batteries from the battery compartment and dispose of them properly [page 40].
5. Insert the new batteries into the battery compartment observing the correct polarity.
6. Place the battery compartment cover back onto the device and tighten the screw.

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] .

7 Technical data

Protection class	II (double or reinforced insulation)
Contamination level	2
Protection category (DIN VDE 0470-1, IEC / EN 60529)	IP 30 1st digit: 3 = protection against access to dangerous parts and protection against solid impurities (diameter >2.5 mm) 2nd digit: 0 = no protection against water
Overvoltage category	• CAT III 600 V to earth • CAT IV 300 V to earth
Housing dimensions (length x width x height)	188 mm x 56 mm x 28 mm
Max. clamp opening	27 mm
Weight (batteries included)	0.225 kg
Battery life (alkaline batteries)	approx. 100 h (without background lighting)
Safety measuring lines (item no.: 044145)	
Standard	IEC / DIN EN 61010-031 (VDE 0411-031)
Overvoltage category (only applies to the safety measuring lines, additionally observe the limitations of the device)	• With attachable protective cap: – CAT III 1 000 V to earth – CAT IV 600 V to earth • Without attachable protective cap: – CAT II 1 000 V to earth
Protection class	II (double or reinforced insulation)
Contamination level	2
Max. rated current	10 A
Length	1.4 m
Operation	
Max. barometric altitude	2 000 m
Operating temperature	0 … 50 °C (do not permanently expose the device to sunlight)
Max. relative air humidity	80 % RH (0 … 30 °C), 75 % RH (30 … 40 °C), 45 % RH (40 … 50 °C), non-condensing
Storage (remove the batteries from the device)	
Ambient temperature	-20 … 60 °C (do not permanently expose the device to sunlight)
Max. relative air humidity	80 % RH

Table 16: 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.

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