Handheld Micro Ohmmeters

RMO-H series

Manual

Manual Version: M-RH00NN-309-EN
This Manual refers to the firmware version 1.xx, 2.xx, 3.xx and 4.xx
RMO-H1, RMO-H2, RMO-H3, RMO-H21, RMO-H22, RMO-H23 models
Publishing date: 2023-07-06

Contents

1 Introduction

This Manual provides instructions on how to use the RMO-H instruments safely, properly and efficiently. The following instructions will help the user avoid unsafe situations, reduce maintenance costs and will ensure the reliability and durability of the RMO-H instruments.

The RMO-H must be used in accordance with all existing safety requirements and regulations based on national/local standards for accident prevention and environmental protection. In addition, the relevant international standards are listed in the “Technical Data” paragraph section of this document.

1.1 Safety Instructions

Safety is the responsibility of the user. Before operating the RMO-H, please read the following safety instructions carefully.

It is not recommended the RMO-H being used (or even turned on) without careful observation of the instructions listed in this Manual. The RMO-H should only be operated by trained and authorized personnel.

1.1.1 Safety Terms and Symbols

Terms in this Manual

These terms may appear in the Manual:

WARNING: Warning statements identify conditions or practices that could result in an injury or a loss of life.

CAUTION: Caution statements identify conditions or practices that could result in damage to this product or to the other property.

Terms on the Device

The following warning terms used in this document may appear on the device:

WARNING: indicates that a potential hazard may occur.

CAUTION: indicates that a potential damage may occur to the instrument or to the test object connected to the instrument.

Symbols on the Device

The following symbols may appear on the device:

Refer to Manual

Protective Earth Terminal

1.1.2 Terms of Use

- The RMO-H shall be used only if it is in a good technical condition. Its use shall be in accordance with local safety and industrial regulations. Adequate precautions must be taken to avoid any risks related to high voltages associated with this equipment and nearby objects.
- The RMO-H shall be used only for the application purposes described in the ”Intended Use” section. The manufacturer and distributors are not liable for a damage resulting from the wrong usage. The user bears responsibility for not following the instructions defined in this document.
- Do not remove the protective casing of the RMO-H.
- All service and maintenance work must be performed by qualified personnel only.

1.1.3 Orderly Practices and Procedures

- The Manual shall always be available on the site where the RMO-H is used.
- Before using the RMO-H, all personnel (even personnel who only occasionally, or less frequently, work with the RMO-H) assigned to operate the RMO-H should read the operations Manual.
- Do not make any modifications, extensions, or adaptations to the RMO-H.
- Use the RMO-H only with the original accessories provided by the manufacturer.
- Use the RMO-H and its original accessories for the device’s intended use only.

1.1.4 Device maintenance

Device should be kept in a clean condition to prevent excessive dust or other contaminants affecting its operation. It should be cleaned with water/isopropyl alcohol after noticing any dirt/contaminants on its surfaces.

1.1.5 Battery maintenance

Lithium Polymer (LiPo) batteries are a class of secondary lithium-based batteries. Because of the presence of lithium in this kind of battery, improper handling can lead to ignition or even explosion of the battery. However, with proper handling of DV Power devices during operation and storage, and proper disposal of worn batteries used in DV Power devices, the possibility of a negative outcome is minor. The average life time of a LiPo battery is 2 - 3 years, or 300 to 500 charge / discharge cycles. One charge / discharge cycle implies charging up to the maximum (95 – 100%) capacity and discharge to minimum (10 – 20%). Nevertheless, a stored, fully charged, battery pack loses capacity much faster (irreversibly) than a battery stored at 30 – 50% of nominal capacity.

Because of this, DV Power devices are always shipped with batteries charged to „storage voltage“, which is represented as 40 – 50% of the full capacity on the display. If the user wants to perform measurements with the device, it is recommended to charge the battery not earlier than one day prior the actual use. The battery is considered fully charged at 95 %.

NOTE: If the device is to be stored (not used) for more than 2 – 3 days, DV Power recommends to discharge the battery to storage voltage (40 – 50%) which is in accordance with safety measures and also prolongs battery life. In case the device is stored for longer time, it is recommended to check at least once a month if the battery’s voltage is within the stated storage voltage. It is not recommended to store the device at temperatures above 60°C, but it is best to store at a temperature of 23°C ± 5°C, in a dry place. Please refer to Section 3.4 Settings → Storage mode.

Worn batteries should be disposed of in special containers in accordance with local regulations. Different regulations are applicable for different countries, but in most states it is common that Li-Ion and similar lithium-based batteries should not be disposed of in standard waste containers.
Batteries must be fully discharged prior to disposal.

1.1.6 Operator Qualifications

- Testing with the RMO-H should only be carried out by authorized and qualified personnel.
- While receiving training, instruction or education on the RMO-H device personnel should remain under the constant supervision of an experienced operator while working with the test set and the test object.

1.1.7 Safe Operating Procedures

- Before putting the RMO-H into operation, check the test set for any visible damage.
- Do not operate the RMO-H under wet or moist conditions (condensation).
- Do not operate the RMO-H if explosive gas or vapors are present.
- Only the external devices which meet the requirements for SELV equipment according to EN 60950 or IEC 60950 should be connected to the RMO-H through the serial interface.
- Removing the RMO-H protective casing will void the warranty. Any work inside the instrument without prior authorization from DV Power will also void the warranty.
- If the RMO-H seems to be malfunctioning, please contact the DV Power Support Team (refer to the “Manufacturer Contact Information” section) after previously checking the “Error Messages” section.
- Do not use the RMO-H without the extra protective ground cables supplied with the RMO-H. It must never be operated in a non-grounded configuration as this may result in an electrical shock to the user or damage the RMO-H. Always establish this connection first before establishing any other connections and remove this connection as the very last one.

1.2 Intended Use

Typical application is accurate low resistance measurement during manufacturing, commissioning and maintenance inspections on:

- High and medium voltage Switchgears and Circuit Breakers (as per IEC 62271-100 standards)
- High and medium voltage Disconnecting Switches (as per IEC 62271-100 standards)
- High-current Busbar joints
- Terminals of the conductors on HV power lines
- Bonding of Lighting conductors

RMO-H instruments are also ideal testing tool for quality control checking during production process of high-voltage equipment and equipment used in railway and aircraft industry:

- Welding joints
- Cable splices and cable resistance
- OLTC contacts checking (off-line, not connected to transformer)
- Railway joints, lines and conductor rails
- Bonds and joints checking in aircraft manufacturing industry

CAUTION: Any use of the RMO-H other than mentioned above is being considered improper and will void the warranty and exempt the manufacturer from its liability for repair or exchange.

2 Description

The RMO-H series – battery operated and handheld micro-ohmmeters are unique solution for the contact resistance measurement of switchgears according to international standards (e.g. IEC 62271-100). RMO-H can be used for number of applications where non-inductive resistance is checked, during factory inspections or testing in the high-induction field environments. The set is equipped with the overcurrent protection.

RMO-H Series contains six models in total, divided in 2 sub-series depending of the test leads length requirement and the battery type:

- **RMO-H1**, **RMO-H2** and **RMO-H3** models are intended for use with up to 5 m cables. 1-cell Li-Po battery with 8800 mAh capacity provides output voltage up to 4,2 V DC.
- **RMO-H21**, **RMO-H22** and **RMO-H23** models are ideal for applications where test leads longer than 5 m are required. The high output voltage (up to 8,4 V DC) is provided by 2-cell 4400 mAh Li-Po battery.

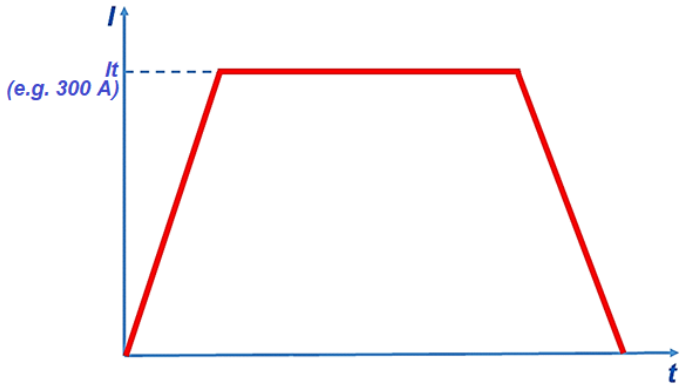
The test current is regulated and can be selected in a range of 1 A to maximum 300 A, depending of the maximum test current rating:

- **RMO-H1**, **RMO-H21** models - up to 100 A DC
- **RMO-H2**, **RMO-H22** models - up to 220 A DC
- **RMO-H3**, **RMO-H23** models - up to 300 A DC.

The high-capacity Li-Po battery enables generating a true DC ripple-free current. The main advantages of LI-Po technology over ultra-capacitor technology are:

- **No rest time needed between tests** since there is no ultra-capacitor charging.
- **Test current is regulated** and it is not load-dependent like in case of ultra-capacitor. This means that user can select certain current value for the measurement (e.g. 1 A, 5A, 10 A, 20 A, 50A, 100 A, 150 A, 200 A, 250 A and 300 A for RMO-H3 model).

With use of automatic test ramp (picture bellow), the test current is gradually increased before the measurement and decreased after the measurement is competed. This significantly decreases influence of magnetic transients.



The RMO-H instrument can internally store up to 1000 measurements (time and date stamped).
DV-Win software enables download of the results, creating and exporting test reports in different formats.
Communication between the RMO-H and a PC is through a Bluetooth communication.

2.1 Front Panel Components

Figure 2-2:
Front panel components

1 – LCD Display
TFT LCD 2.8 in (43,2 mm x 57,6 mm / 1.8 in x 2.3 in)

2 – Keyboard
Used to control the device

3 – Current output terminal (+)

4 – Current output terminal (–)

5 – Protective Earth Connector
Used for protection against parasitic currents or voltages

6 – Charger Connector

7 – Connectors for the voltage sense cables
(+) *Standard banana connector (red)*
(–) *Standard banana connector (black)*

8 - Remote control connector
Trigger button at Kelvin probes

Figure 2-3:
Voltage sense and remote control connectors

CAUTION:
For protection against parasitic currents or voltages, always connect the RMO-H protective earth connector to the protective earth (PE).
Please use only the manufacturer provided cable.
For safety reasons, always establish the protective earth connection before establishing any other connection, and remove this connection as the very last step.

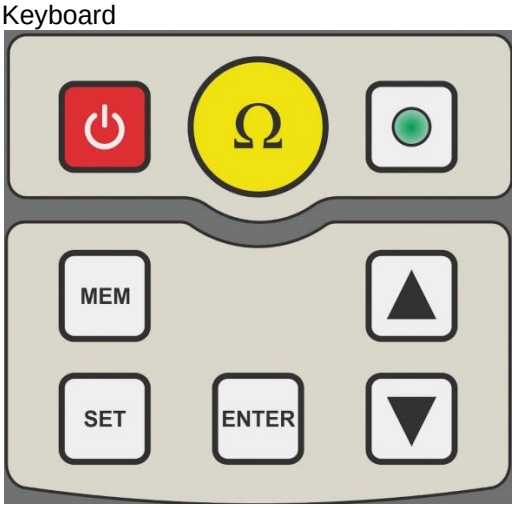
Charger Connector
The connector for charging the internal battery.

Operator Control

2.8 inches color display
Displays the settings as well as the measured values during and after a test operation.

Keyboard

Figure 2-4:
Keyboard



Use this button to turn on/off the device.

Use the **Ω** button to start the test.

Use the ***ENTER*** button to confirm the defined test parameters, language, time, date and limits.

Use the ***UP***/***DOWN*** buttons to navigate through active menu.

Use the ***MEM*** button to go to Memory Menu.
Use the ***SET*** button to go to Settings Menu.

3. Getting Started

3.1 Connecting RMO-H to Test Object

NOTE:
Cables should be connected and removed to/from RMO-H device ONLY when the RMO-H is switched off.

CAUTION:
Before any connecting of measuring cables connect manufacturer provided earthing cable to the RMO-H and then to earthing system.
Always connect the measuring cables to the RMO-H first and then to the test object; and when disconnecting, always disconnect the cables from the test object first and after that from the RMO-H. The grounding wire PE should be disconnected last. Failure to do this may result in a serious injury or even a loss of life.

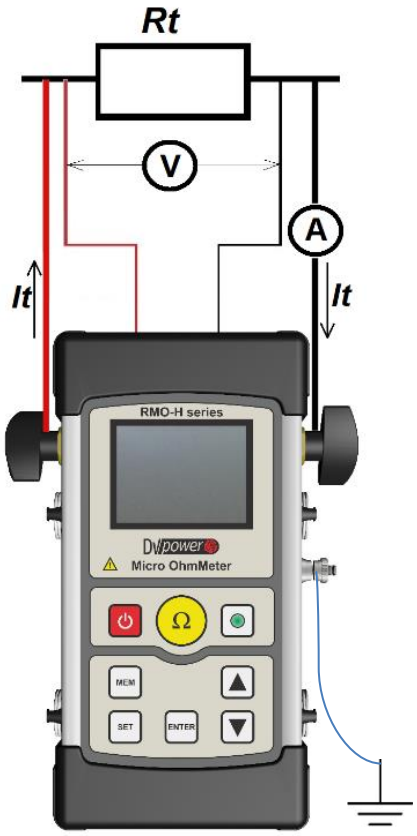


Figure 3-1: Connecting a test object to RMO-H

With RMO-H turned off, connect RMO-H to the test object R_t in such a way that the Voltage sense clamps are attached as close as possible to the test object R_t, and closer to R_t than the connection points of the current feeding clamps. That way, resistance of both, cables and clamps is excluded from the resistance measurement.

Please pay attention to the polarity while connecting the measuring cables, otherwise the measurement results will not be accurate.

To maximize accuracy and measurement repeatability make sure that all clamps have a good connection to the test object and pay attention to avoid any connection between Sense and Current clamps.

In case that combined current and sense cables are provided with the RMO-H device, the user only needs to connect the TTA clamps/Kelvin probes to the connection points. The resistance between these points will be measured by the device.

3.2 Connecting RMO-H to Circuit Breaker

NOTE: Before connecting the RMO-H to a circuit breaker make sure that:

- **circuit breaker is disconnected or separated from its circuit on both sides of the breaker in accordance with the national safety regulations; always comply with local safety regulations when using the RMO-H,**
- **circuit breaker is in closed position,**
- **circuit breaker is properly grounded at one side to a protective earth (PE),**
- **RMO-H itself is properly grounded. To do so, connect the grounding screw of the RMO-H to a PE using only the manufacturer provided grounding cable.**

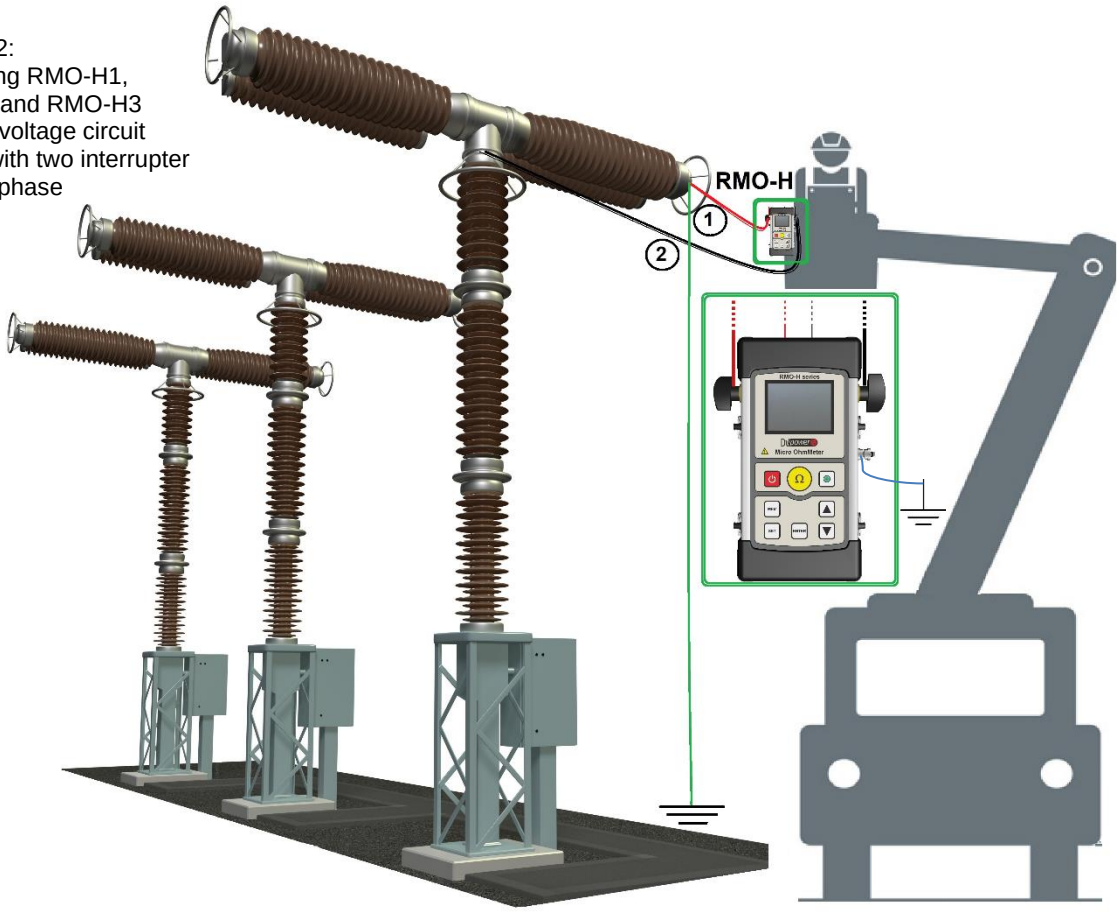
Since RMO-H1, RMO-H2 and RMO-H3 are handheld devices, they can be used with short cables (e.g. 1,3 m and 3 m) even in case of live-tank circuit breakers, switchgears or power cable terminals testing.

A test operator can bring the device with himself in the bucket lift, connect test cables directly to each breaking chamber terminals (or some other measurement point) and take measurement (1-click to test principle). In this case, a different cable's length could be used. Typically, the short cable (red cable, 1,3

m) connects the RMO-H to the CB's terminal which is closer to the test person and the device, while long cable (black cable, 3 or 5 m) is connected to the distant terminal on the other side of the interrupter unit.

The connection diagram to a one-side grounded circuit breaker is illustrated in the figure below:

Figure 3-2:
Connecting RMO-H1, RMO-H2 and RMO-H3 to a high-voltage circuit breaker with two interrupter units per phase



1. ***Short test leads (current and voltage sense cables labeled with red color)***
2. ***Longer test lead (current and voltage sense cables labeled with black color)***

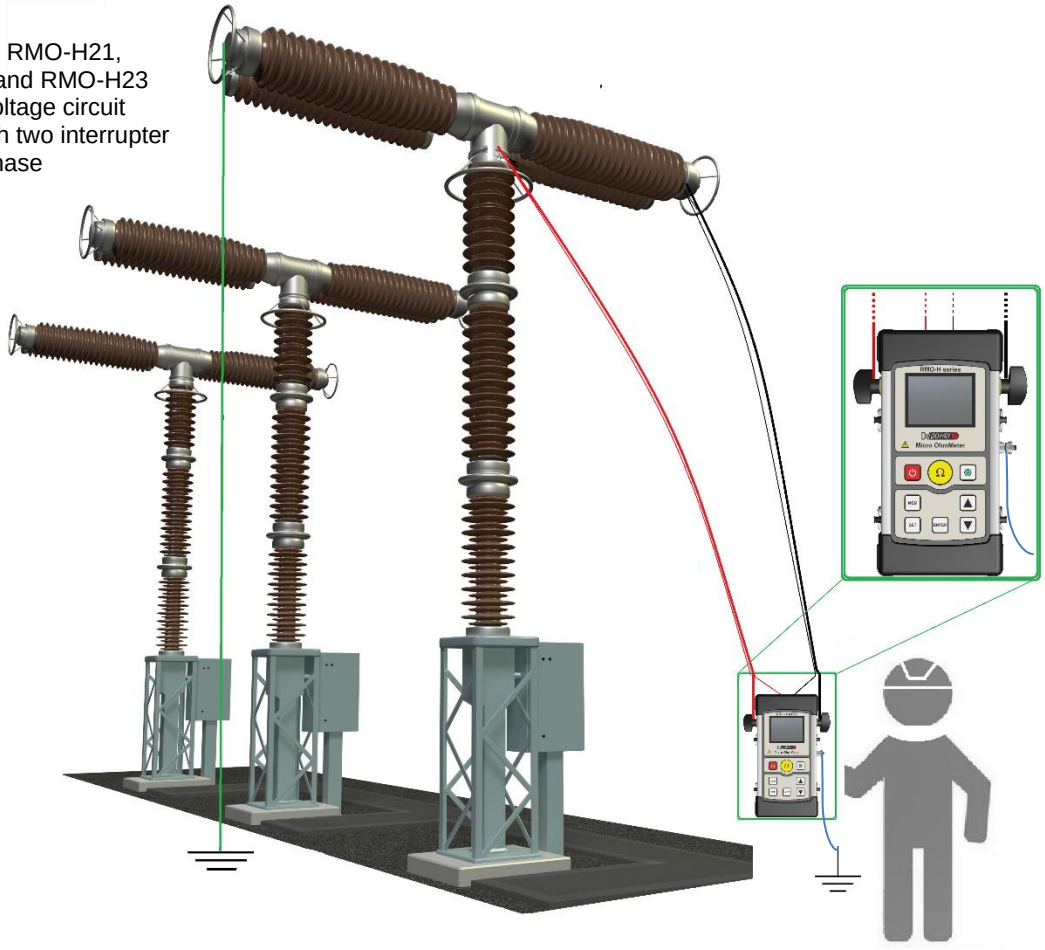
Internal testing procedures in some utilities or service companies may require use of 5 m or longer cables for testing high voltage live-tank circuit breakers. In the case of such requirement RMO-H21, RMO-H22, or RMO-H23 models should be applied. This is conventional (traditional) procedure for contact resistance measurement. Although long cables usually lead to very heavy current carrying cables, this is not case for RMO-H21, RMO-H22 and RMO-H23 devices. This is achieved with high output voltage (up to 8,3 V DC).

NOTE:

RMO-H1, RMO-H2, RMO-H3 models DO NOT have interchangeable test leads with RMO-H21, RMO-H22, RMO-H23 models. All RMO-H devices should be used only with test cables provided by the manufacturer (DV Power). The list of accessories for all RMO-H models is stated in the Section 9 – "Device and Accessories" of this document.

The connection diagram of RMO-H21, RMO-H22 and RMO-H23 devices to live-tank circuit breaker is presented in the Figure 3-3.

Figure 3-3: Connecting RMO-H21, RMO-H22 and RMO-H23 to a high-voltage circuit breaker with two interrupter units per phase



When testing the medium voltage circuit breakers, it is convenient to use Current and Sense cables with Kelvin probes.

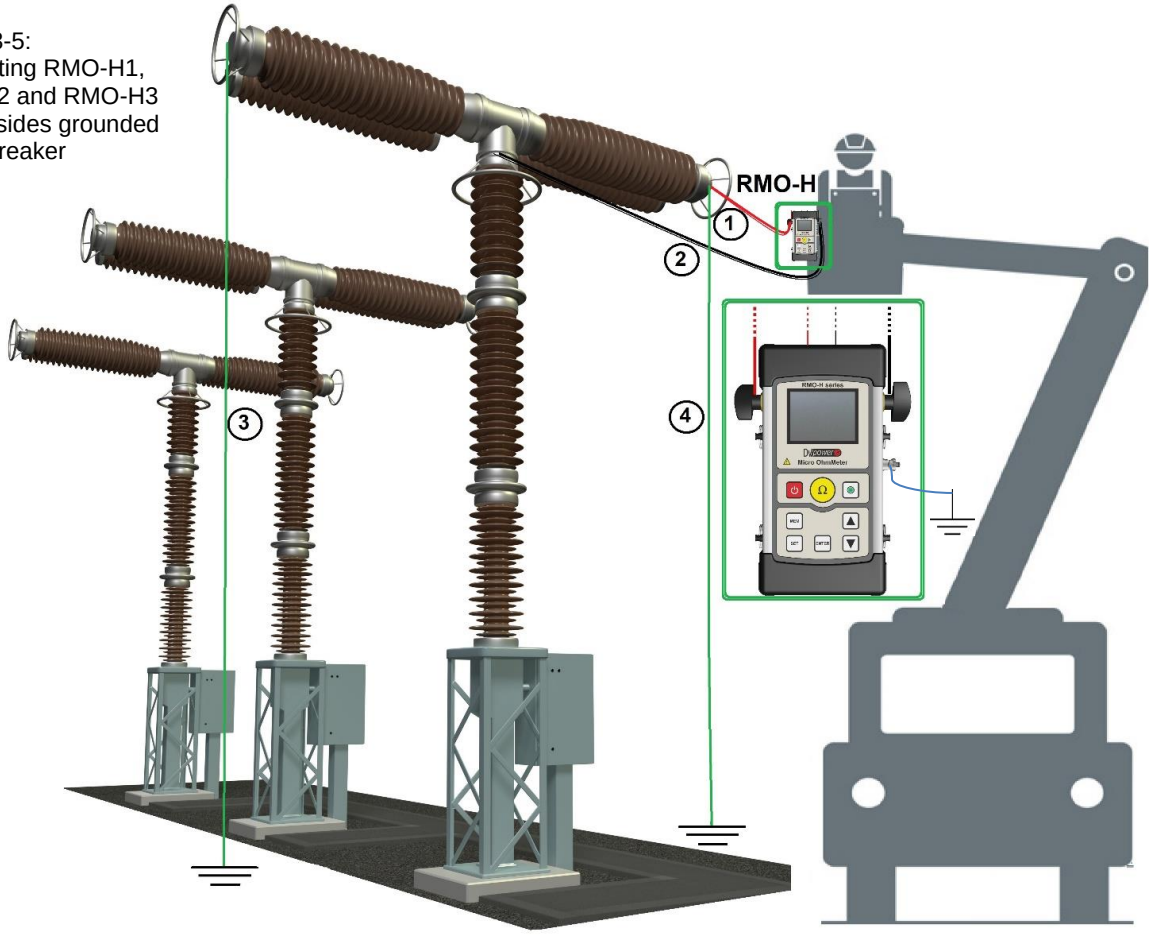
Figure 3-4: Connecting RMO-H to circuit breaker using cables with Kelvin probes

3.3 Connecting RMO-H to Both Sides Grounded (BSG) Circuit Breaker

The RMO-H device provides a safer measurement approach to the breakers with both terminals grounded. In case of both sides grounded circuit breaker, induced current cannot be a treat to the test personnel.

The connection diagrams of the RMO-H1, RMO-H2 and RMO-H3 devices applied to both sides grounded circuit breaker is presented in the following figure.

Figure 3-5: Connecting RMO-H1, RMO-H2 and RMO-H3 to both sides grounded circuit breaker



1. ***Short test leads (current and voltage sense cables labeled with red color)***
2. ***Longer test lead (current and voltage sense cables labeled with black color)***
3. ***Ground cable***
4. ***Ground cable (used in case of Both Sides Grounded testing)***

The above mentioend connection principle is valid for RMO-H1, RMO-H2 and RMO-H3 models which use test leads up to 5 m length.

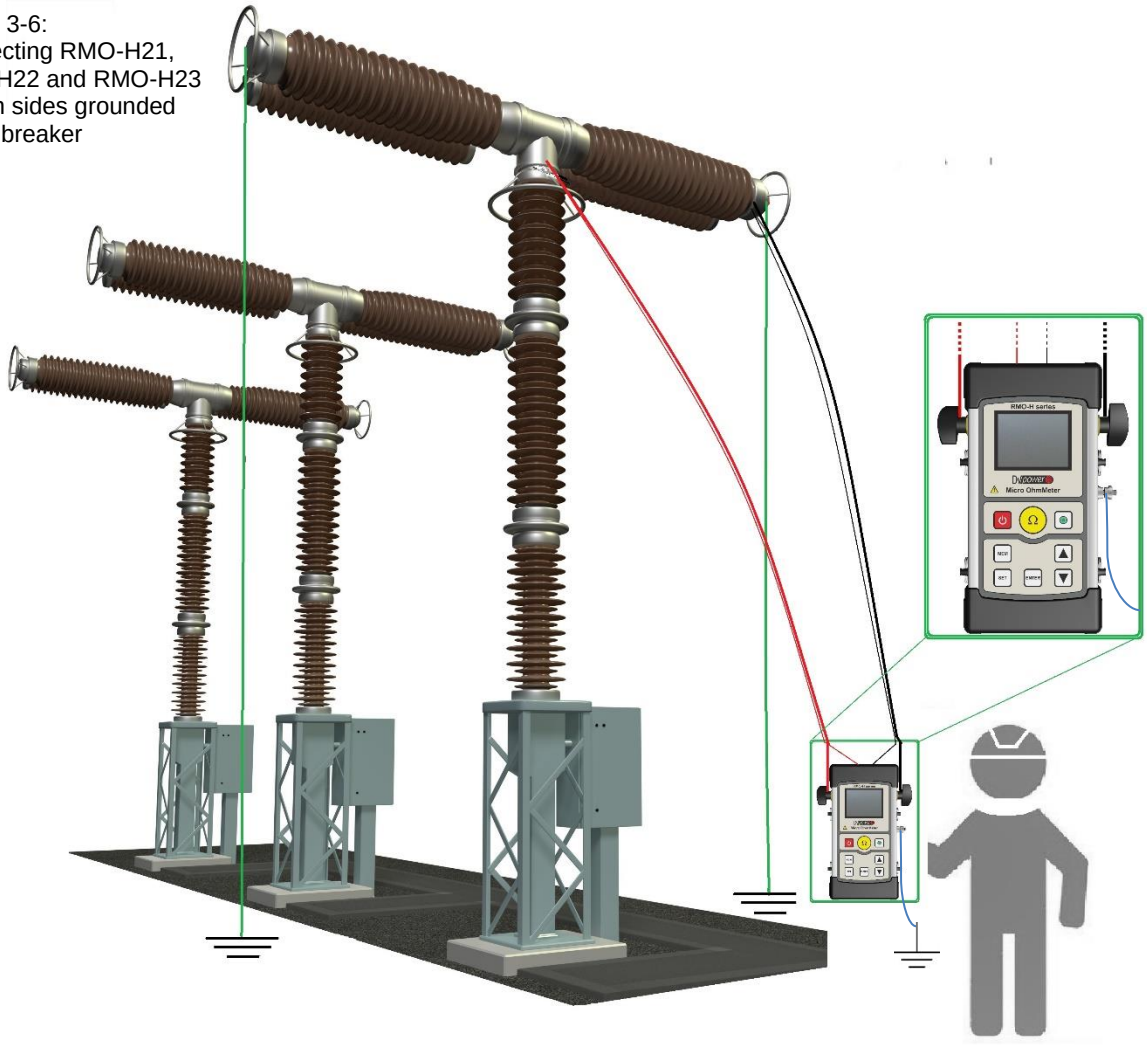
RMO-H21, RMO-H22 and RMO-H23 models use a traditional connection principle („from the ground“) in case of both sides grounded circuit breakers also.

NOTE:

The connection diagram for measurement in the “Both Sides Grounded” conditions, as well as the measurement procedure is the same as for the circuit breakers and switchgears grounded only at one side (please refer to Section 3.2).

The connection diagrams of the RMO-H21, RMO-H22 and RMO-H23 devices applied to both sides grounded circuit breaker is presented in the following figure.

Figure 3-6:
Connecting RMO-H21, RMO-H22 and RMO-H23 to both sides grounded circuit breaker



NOTE:

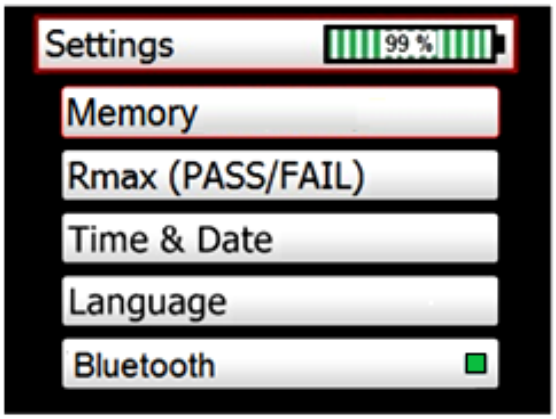
This type of measurement could be less accurate comparing to the measurement in one-side-grounding conditions, because of some amount of the current that will flow through groundings.

3.4 Settings

If the RMO-H device is turned ON for the first time, or some additional system settings are required, pressing the ***SET*** button will invoke the **Settings** menu, as illustrated below.

In the **Settings** menu Memory, Limits, Time & Date, Language parameters can be modified. In addition, the Bluetooth option can be enabled/disabled. The ***UP*** and ***DOWN*** buttons are used for navigation and the ***ENTER*** button for entering the selected submenu.

Figure 3-7:
The **Settings Menu**

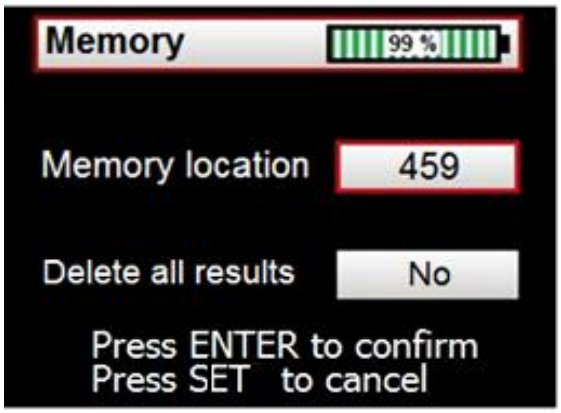


Setting Memory

To set default memory location on RMO-H, please use ***ENTER*** button to activate the **Memory** menu. In the **Memory** menu, use ***UP*** and ***DOWN*** buttons to change values (status) in the selected fields.

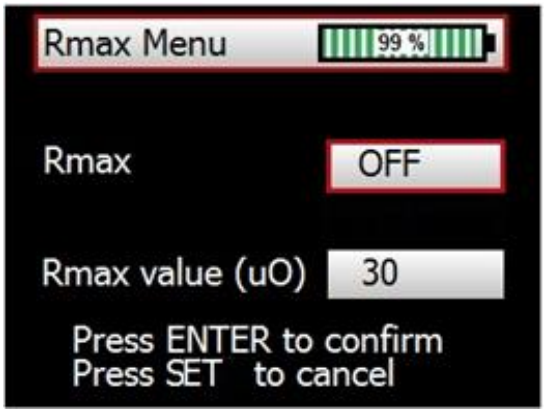
ENTER button is used to confirm and ***SET*** button to cancel selected values (status).

Figure 3-8:
The **Memory** screen



Setting Rmax

Figure 3-9:
The **Rmax** screen

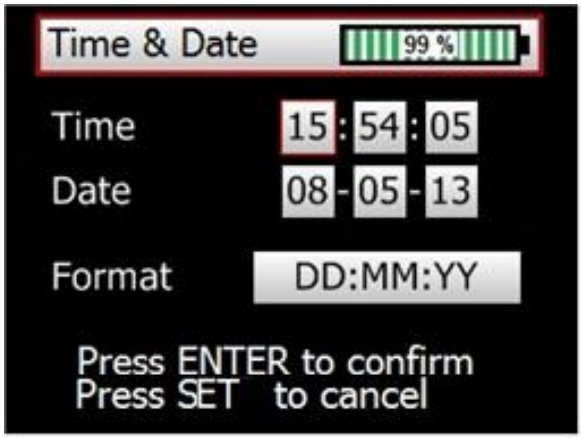


In the **Rmax** menu, define the status of **Rmax** (**On** or **Off**) and the assigned value of resistance.
Using ***UP/DOWN*** buttons select **Off** (Figure 3-9) or **On** option in order to DISABLE/ENABLE Rmax function.
Press ***ENTER*** to confirm and change cursor on Rmax value field.
Using ***UP/DOWN*** buttons in *Rmax value field* select a desired value between 1 μΩ and 1999 μΩ. The default value is 100 μΩ. When the device is turned off and then turned on, the RMO-H remembers the last saved setting of an Rmax value and a status.
Once these parameters are defined, press ***ENTER*** to return to the **Settings** menu.

Setting Time & Date

To set RMO-H's date and time, please use the ***UP/DOWN*** buttons, and then ***ENTER*** button to select the **Time & Date** menu.

Figure 3-10:
The **Time & Date** screen



Change the values in the selected fields with the ***UP/DOWN*** buttons and use ***ENTER*** button to confirm set values.

One of three different date formats can be selected:

1. YY-MM-DD
2. DD-MM-YY
3. MM-DD-YY

Pressing ***ENTER*** to confirm, returns you to the **Settings** menu with updated values.
Pressing ***SET*** to cancel, returns also to the **Settings** menu, but without saved Time & Date settings.

Setting Language

To set RMO-H's language, please use the ***UP/DOWN*** buttons, and then ***ENTER*** button to select the **Set Language** menu.

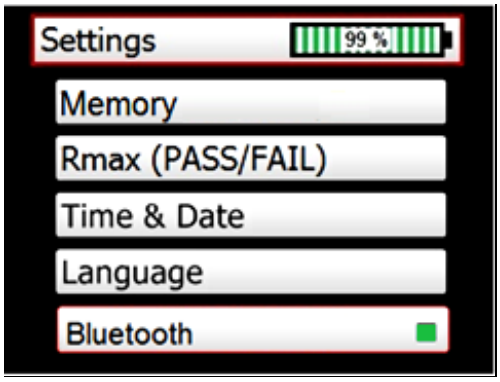
Figure 3-11:
The **Language** screen

Pressing ***ENTER*** to confirm, returns you to the **Settings** menu with updated values.
Pressing ***SET*** to cancel, returns also to the **Settings** menu, but without saved Language settings.

Setting Bluetooth (ON/OFF)

To activate the Bluetooth communication with computer (DV-Win software), press the ***ENTER*** button when the "Bluetooth" field is selected. When Bluetooth is activated, bluetooth sign will apear at the status line and the Setting screen looks like in the figure 3-12 below:

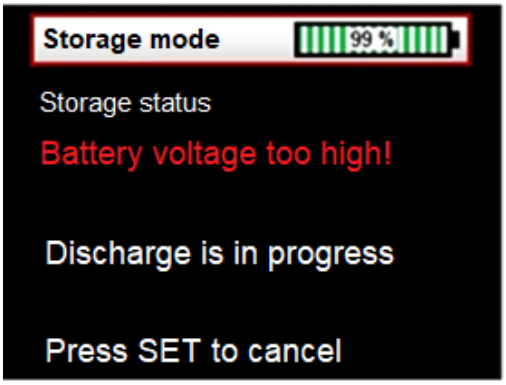
Figure 3-12:
The **Bluetooth** activation



Storage mode (for battery)

As mentioned in the **Section 1.1.5**, Storage mode is created for safe discharging the device battery to storage voltage (40 – 50%). When Storage mode is activated, the storage status is displayed on screen. If the battery voltage is higher than recommended storage voltage, the following screen will be displayed.

Figure 3-13:
The **Storage** mode

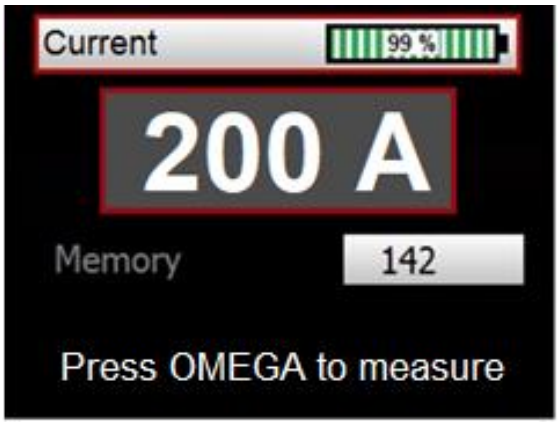


NOTE: When the storage mode is activated, the device will automatically shut down when the battery storage voltage is reached.

3.5 Measuring with RMO-H

The start screen for setting the measurement parameters is presented in the figure below:

Figure 3-14:
Setting the test current in start screen



User can set the test current by using ***UP/DOWN*** buttons. The following test current values can be selected:

- RMO-H1 & RMO-H21 models: 1 A, 5 A, 10 A, 20 A, 50 A, 100 A.
- RMO-H2 & RMO-H22 models: 1 A, 5 A, 10 A, 20 A, 50 A, 100 A, 150 A, 220 A
- RMO-H3 & RMO-H23 models: 1 A, 5 A, 10 A, 20 A, 50 A, 100 A, 150 A, 200 A, 250 A & 300 A.

No additional setting is needed for starting the test. The measurement can start by pressing the **Ω** button or with the trigger button on the Kelvin probes.

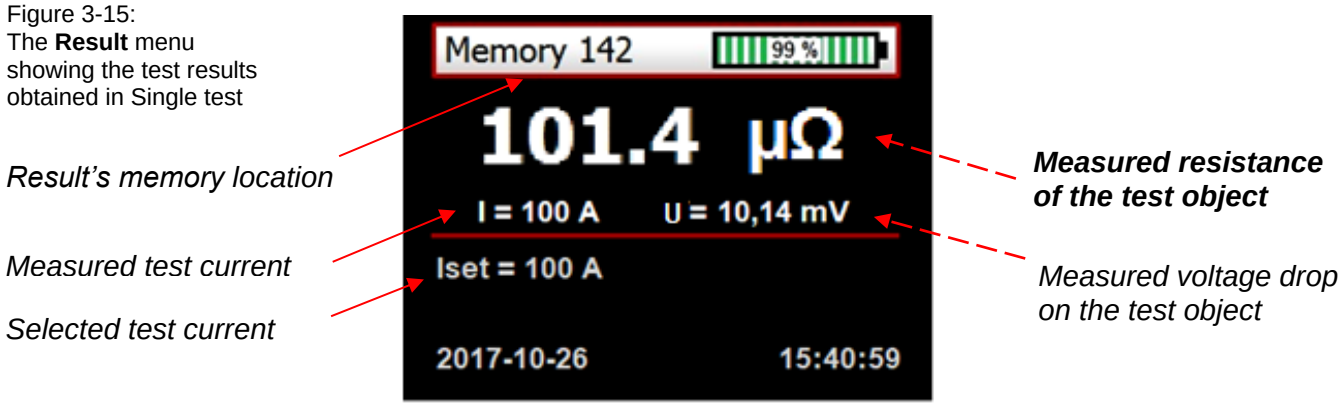
NOTE:
When the test is started, the green led diode will flash along with short buzzer sound.

Once a test is finished, the RMO-H automatically changes to the **Result** menu to display the test results with the following parameters:

- measured resistance value
- measured test current value (**I**) and selected test current value (**Iset**)
- measured voltage drop (**U**)

All test results are **date and time stamped** and automatically stored in the device internal memory.

Figure 3-15:
The **Result** menu showing the test results obtained in Single test

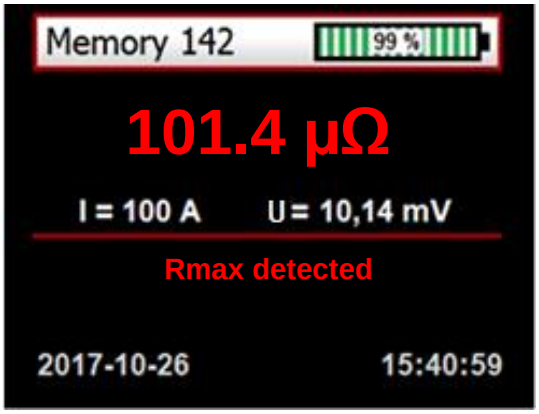


If the measured value is >3 Ω, the following message will be diplayed: ***Resistance out of range!***

3.5.1 Test Results with Rmax Function Enabled

If the **Rmax** menu is set to option **ON**, once the test is finished, RMO-H automatically changes to the **Rmax** to display the test results. In case the measured resistance is equal to or greater than maximum assigned value, the result will be displayed in “red” color, as presented in the figure below:

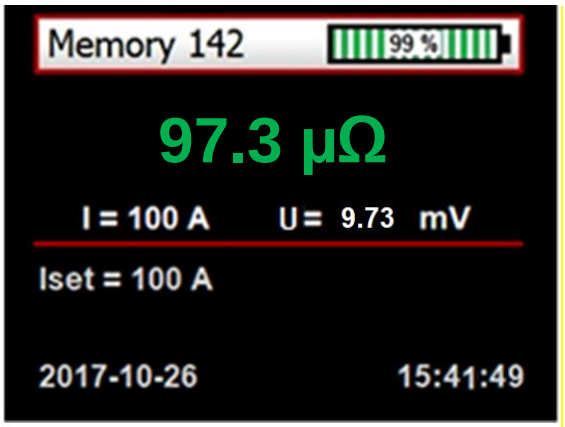
Figure 3-16:
The test results when **Rmax** value is reached



NOTE:
When R_{max} value is detected ($R \geq R_{max}$), the buzzer sound will be activated for 5 s.

In case the measured resistance is lower than set R_{max} value the result will be displayed in “green” color, as presented in the figure below:

Figure 3-17:
The test results when **Rmax** value is not reached



NOTE:
The default value for R_{max} is 100 µΩ. When the device is turned off and then turned on, the RMO-H remembers the last saved setting of an R_{max} value and a status.

3.6 Measurement parameters

The table below provides RMO-H device accuracy parameters under the maximal test current per the range being used.

Table 3-1: *Measurement parameters for RMO-H*

Range	Nominal Resistance	Full Range Display	Resolution	Recommended Test Current	Typical accuracy
1	1 mΩ	999,9 µΩ	0,1 µΩ	50 A – *300 A	± 0,1 % rdg ± 0,1 % FS
2	10 mΩ	9,999 mΩ	1 µΩ	10 A – *300 A	± 0,1 % rdg ± 0,1 % FS
3	100 mΩ	99,99 mΩ	10 µΩ	5 A – 30 A	± 0,1 % rdg ± 0,1 % FS
4	1 Ω	999,9 mΩ	0,1 mΩ	1 A – 3 A	± 0,1 % rdg ± 0,1 % FS
5	3 Ω	3000 mΩ	1 mΩ	1 A	± 0,25 % rdg ± 0,25 % FS

For RMO-H1 & RMO-H21 models, the maximum test current is 100 A and for RMO-H2 & RMO-H22 it is 220 A DC.

****The measurement parameters stated in the table are valid at the rated battery voltage, + 25 °C ambient temperature and use of recommended accessories.***

The following duty cycles (rest time) will be activated after 4 subsequent tests:

Table 3-2: *Duty cycles after 4 subsequent test*

4 subsequent tests	Cooling time (rest time)
after 4 tests with I < 100 A	0
after 4 tests with 100 A	15 s
after 4 tests with 150 A	20 s
after 4 tests with 200 A	25 s
after 4 tests with 250 A	35 s
after 4 tests with 300 A	50 s

NOTE:
Up to 4 consecutive tests can be done with no rest time needed between tests.
For test currents less than 100 A, there is no duty cycle defined (no rest time).
This is advantage of Li-Po technology over ultra-capacitor technology, where user needs to wait for capacitor to charge between the tests.

3.7 Measurement Limitations for RMO-H2X Devices

RMO-H2X devices have a firmware limitation for setting the current higher than 200 A. When the battery capacity drops below 60%, the firmware does not allow setting the current to 300 A, and when the battery capacity drops below 47%, the firmware does not allow setting the current above 200 A.

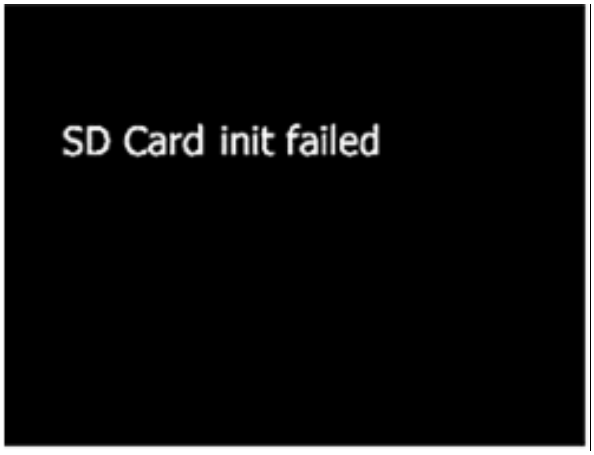
4 Error Messages

Any operational error is indicated by an error status message.

4.1 Error Message "SD Card Initiation Failed"

The RMO-H device has a built-in SD card. The SD card is used to store internal device information and is not accessible to the user. The SD cards are initialized during the device startup stage. If there is no SD card in the SD card slot, or if the initialization is not successful, the following message will be displayed. In case the message is frequently displayed, please contact the DV Power Customer Support Department.

Figure 4-1:
Error message
"**SD Card init failed**"

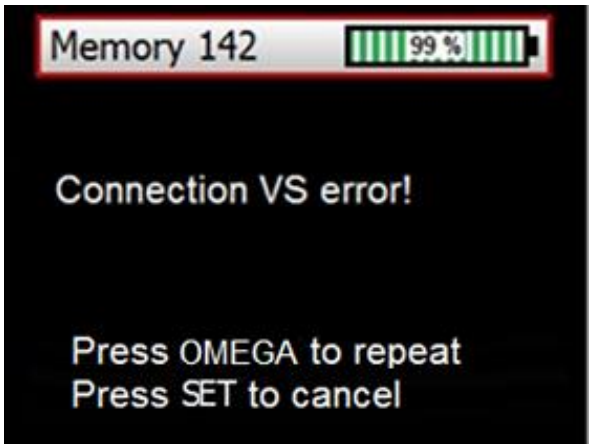


The device will display the message for three seconds and return to the Main Menu.

4.2 Error Message "Connection VS"

If one of the "Voltage Sense" cables is disconnected from the test object, or from the test set at the start of the test, the error message "Connection VS" is displayed.

Figure 4-2:
Disconnection of a
"**Voltage Sense**" cable
and corresponding
error message

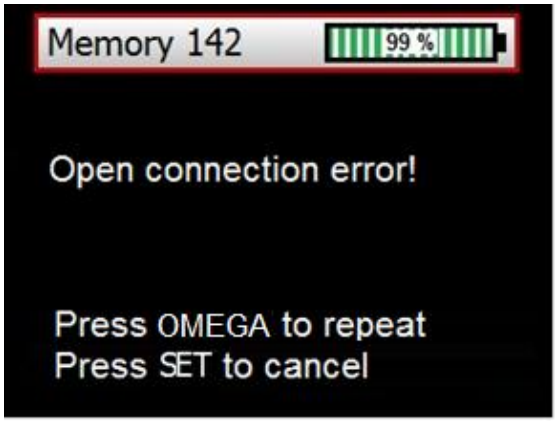


NOTE:
Voltage Sense cables disconnection, occurred during the test, will provide an erroneous result. The display will not show this as an error message.

4.3 Error Message "Open Connection"

If one of RMO-H Current Cables ("+" or "-") is disconnected, from the test set or from the test object at the start or during the test, the error message "Open Connection" is displayed.

Figure 4-4: Disconnection of the current cables and corresponding error message



NOTE:
The error message "Open Connection" can be displayed not only in case one of the current cables is disconnected, but also in case of high test resistance due to bad contact. It is recommended to clean the contact surface of the circuit breaker terminal before testing with the RMO-H device.

5 Troubleshooting

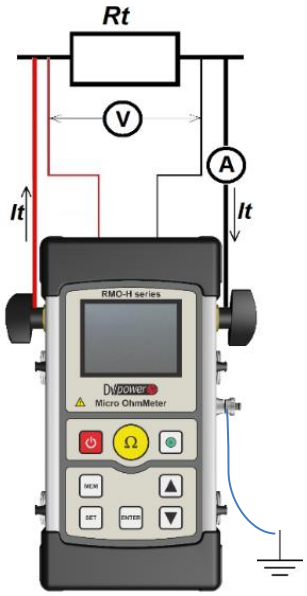
If it is suspected the device is presenting inaccurate results, the following tests should be performed:

5.1 Measurement Accuracy Check

If it is suspected that the device is presenting inaccurate results, the accuracy check described below should be performed:

1. Connect the RMO-H instrument with the test shunt 100 μΩ, as it is shown in the Figure 5.1.
2. Turn ON the RMO-H instrument.
3. Perform tests with 100 A, 150 A and 200 A test currents.
4. Repeat the same procedure with the test shunt 1 mΩ.
5. If it is suspected that the instrument is measuring inaccurately, please send e-mail to DV Power support team (support@dv-power.com) with the following information:
   - Declared test shunt resistance value,
   - Declared accuracy of the test shunt
   - Result measured with the instrument (resistance, voltage drop and generated current).

Figure 5-1:
Connection scheme



5.2 Battery check

If it is suspected that the device is having battery issue or if it is not possible to turn ON the RMO-H instrument, procedure described below should be performed:

1. Turn ON the RMO-H instrument.
2. Connect the RMO-H instrument to the charger.
3. Check if the battery is charging (charging is illustrated in the battery symbol – upper right part of the display)
4. If it is not possible to turn ON the RMO-H, connect it to the charger and again try to turn ON the instrument.
5. If the instrument is able to turn ON when it is connected to the charger, wait until the battery is fully charged.
6. Turn OFF the device, disconnect the charger and again try to turn ON the instrument.
7. If the instrument is able to turn ON, the battery is working properly.

6 Customer Service

Before calling or sending an e-mail to Customer Service for assistance, please perform the following steps:

1. Check all cable connections.
2. Try the test on another instrument, if available.
3. Perform the troubleshoot procedure.
4. Have the following information available:
   - Instrument serial numbers, hardware configuration, and software revision
   - Exact description of the problem, including the test object information, error messages and the sequence of events before it appeared
   - List of solutions that have been tried

The Customer Support Department can be reached at:

Local Support (Sweden): +46 8 731 78 23

Europe, Africa, Asia and Australia Support: +46 70 0925 000

Germany Support: +49 175 10 10 178

USA Support: +1 800 599 8113 (available until 16:00 EDT)

Latin America Support: +46 8 731 78 24

WhatsApp support: +46 70 0925 000

E-Mail: support@dv-power.com

NOTE:
Email communication is preferred for support issues, since the case is then documented and traceable. Also, the time zone problems and issues with occupied telephones do not occur.

7 Packing the Instrument for Shipment

If you need to send the instrument to DV Power for servicing, please contact the DV Power Customer Service for return instructions at:

Local support (Sweden): +46 8 731 78 24

International support: +46 70 0925 000

E-mail: support@dv-power.com

Note: DV Power is not responsible for shipping damage. Please protect each instrument from shipping and handling hazards carefully. Please ensure protective covers are securely in place. Instruments should be sent to DV Power freight pre-paid, unless other arrangements have been authorized in advance by DV Power Customer Service.

To prepare an instrument for shipment, please follow these instructions:

1. Disconnect and remove all external cables. Do not include manuals and cables, unless recommended by DV Power Customer Service.

2. Reuse the original packing material if it is available. If it is not, pack the instrument for shipment according to the instructions for fragile electronic equipment. It is recommended use two-wall minimum corrugated cardboard box with a minimum 5 cm (2 inch) thick poly foam padding, or a wooden crate with minimum of 5 cm (2 inch) thick poly foam padding all around.

8 Technical Data

Battery

- Type: Li-Po (User replaceable)
  1-cell, 8800 mAh *(RMO-H1, -H2, -H3)*
  2-cells 4400mAh *(RMO-H21, -H22, -H23)*
- Recharge time: 2 hours

AC Adapter

- Input voltage: 90 – 264 V AC, 50/60 Hz
- Output voltage: 12 V DC
- Output current: 3 A

Output data

- Test current range:
  - RMO-H1, RMO-H21: 1 – 100 A DC (regulated, user-selectable*)
  - RMO-H2, RMO-H22: 1 – 220 A DC (regulated, user selectable*)
  - RMO-H3, RMO-H23: 1 – 300 A DC (regulated, user selectable*)

  (1 A, 5 A, 10 A, 20 A, 50 A, 100 A, 150 A, 200 A, 250 A, 300 A)
- Maximum output voltage: 4,1 V (RMO-H1, -H2, -H3)
  8,3 V (RMO-H21, -H22, -H23)

Measurement

- Resistance range: 0 – 3000 mΩ
- Resolution

0,1 – 999,9 µΩ	0,1 µΩ
1,000 – 9,999 mΩ	0,001 mΩ
10,00 – 99,99 mΩ	0,01 mΩ
100,0 – 999,9 mΩ	0,1 mΩ
1000 – 3000 mΩ	1 mΩ

- Typical accuracy*: ± (0,1 % rdg + 0,1 % FS): in a range up to 1 Ω
  ± (0,25 % rdg + 0,25 % FS)): in a range from 1 Ω to 3 Ω
- Guaranteed accuracy*: ± (0,2 % rdg + 0,2 % FS):): in a range up to 1 Ω
  ± (0,5 % rdg + 0,5 % FS):): in a range from 1 Ω to 3 Ω

**valid under the maximum test current per the range being used, as defined in the Section 3.6 – Measurement parameters*

CE – marking

- EMC: 2004/108/EC
- LVD: 2006/95/EC

Interface

- Bluetooth: Device to PC connection

Internal Memory

- Internal: 2 GB SD Card
- Results storage: 1000 time and date stamped measurements*
  ***resistance, measured and selected test current, voltage drop.**

Display

- Type: TFT LCD 2.8 in
- Viewing Area 43,2 mm x 57,6 mm / 1.8 in x 2.3 in
- Resolution: 320 x 240 pixels

Dimensions and Weight

- Dimensions (L x W x D): 226 mm x 116 mm x 50 mm
  8.9 in x 4.5 in x 1.9 in
- Weight: 0,95 kg / 2.1 lbs.
- Dimensions (transport case - small): 405 mm x 165 mm x 330 mm
  (W x H x D) 15.94 in x 6.5 in x 12.99 in
  **Small size plastic transport case includes RMO-H1, RMO-H2 and RMO-H3 devices with short cables type (< 5 m)*
- Dimensions (transport case - medium): 478 mm x 194 mm x 390 mm
  (W x H x D) 18.82 in x 7.64 in x 15.35 in
  **Medium size plastic transport case includes all RMO-H models along with 5 m test leads.*

Environmental conditions

- Operating temperature: -10 ºC - +55 ºC / +14 ºF - +131 ºF
- Storage & transportation: -40 ºC - +70ºC / -40 ºF - +158 ºF
- Humidity: 5 % - 95 % relative humidity, non-condensing
- Installation/overvoltage category: II
- Pollution degree: 2

Applicable standards

- Environmental tests – Shock: IEC 60068-2-27
- Environmental tests – Vibrations: IEC 60068-2-6
- Installation/overvoltage: Category II
- Pollution: Degree 2
- Low Voltage Directive: Directive 2014/35/EU (CE conform)
  Applicable standards: EN 61010-1
- Electromagnetic Compatibility (EMC): Directive 2014/30/EU (CE conform)
  Applicable standard: EN 61326-1

All specifications herein are valid at the rated (or higher) battery voltage, ambient temperature of + 25 °C and use of recommended accessories. Specifications are subject to change without notice.

9 Instrument & Accessories

- **RMO-H1, RMO-H2 and RMO-H3 devices**

Instrument with included accessories	Article No
Handheld Micro Ohmmeter RMO-H1	RMOH100-N-00
Handheld Micro Ohmmeter RMO-H2	RMOH220-N-00
Handheld Micro Ohmmeter RMO-H3	RMOH300-N-00
- USB with DV-Win PC software - Ground (PE) cable - Carrying belts - Plastic transport case – small size	
Power supply adapter 3 A EU	PWR-ADP3A-EU

Recommended accessories	Article No
Current and sense cables 2 x 1,3 m with TTA clamps (up to 220 A rated) ***for RMO-H1 & RMO-H2***	CS2-1Z3-10CLWC
Current and sense cables 2 x 1,3 m with TTA clamps (300 A rated) ***for RMO-H3***	CS2-1Z3-25CLWC

Optional accessories	Article No
Current and sense cables 2 x 1,3 m with Kelvin probes (up to 200 A rated) ***for RMO-H1 & RMO-H2***	CS2-1Z3-10CLKP
Current and sense cables 2 x 1,3 m with Kelvin probes (250 A rated) ***for RMO-H3***	CS2-1Z3-16CLKP
Current and sense cables 1,3 m (red) and 3 m (black) with TTA clamps (100 A rated)	CS-1Z33-10CLWC
Current and sense cables 1,3 m (red) and 3 m (black) with TTA clamps (220 A rated)	CS-1Z33-16CLWC
Current and sense cables 1,3 m (red) and 3 m (black) with TTA clamps (250 A rated)	CS-1Z33-25CLWC
Current and sense cables 1,3 m (red) and 5 m (black) with TTA clamps (100 A rated)	CS-1Z35-10CLWC
Current and sense cables 1,3 m (red) and 5 m (black) with TTA clamps (200 A rated)	CS-1Z35-16CLWC
Current and sense cables 1,3 m (red) and 5 m (black) with TTA clamps (250 A rated)	CS-1Z35-25CLWC
Current cables 2 x 1,3 m with TTA clamps (270 A rated) ***for RMO-H3***	C2-1Z3-16CLWC
Sense cables 2 x 1,3 m with alligator clamps (A2)	S2-1Z3-02BPA2
Current cables 1,3 m and 3 m with TTA clamps (220 A rated) ***for RMO-H2 & RMO-H3***	C-1Z33-16CLB1
Sense cables 1,3 m and 3 m with alligator clamps (A2)	S-1Z33-02BPA2
Current cables 2 x 1,3 m with battery clamps (300 A rated) ***for RMO-H3***	C2-1Z3-25CLB1
Current cables 1,3 m and 3 m with battery clamps (100 A rated)	C-1Z33-10CLB1
Current cables 1,3 m and 3 m with battery clamps (220 A rated)	C-1Z33-16CLB1
Current cables 1,3 m and 3 m with battery clamps (250 A rated)	C-1Z33-25CLB1
Sense cables 1,3 m and 3 m with alligator clamps (A2)	S-1Z33-02BPA2
Current cables 1,3 m and 5 m with battery clamps (100 A rated)	C-1Z35-10CLB1
Current cables 1,3 m and 5 m with battery clamps (200 A rated)	C-1Z35-10CLB1
Current cables 1,3 m and 5 m with battery clamps (250 A rated)	C-1Z35-10CLB1
Sense cables 1,3 m and 5 m with alligator clamps (A2)	S-1Z35-02BPA2
Current and sense cables 2 x 5 m with sliding arm Kelvin's clamps (220 A rated)	CS2-05-25CLSK
Test shunt 240 µΩ (250 A/60 mV)	SHUNT-240-MK
Test shunt 1 mΩ (150 A/150 mV)	SHUNT-150-MK
Power supply adapter (car charger)	PWR-ADP3-CC0

- **RMO-H21, RMO-H22 and RMO-H23 devices**

Instrument with included accessories	**Article No**
Handheld Micro Ohmmeter RMO-H21	RMOH100-N2-0
Handheld Micro Ohmmeter RMO-H22	RMOH220-N2-0
Handheld Micro Ohmmeter RMO-H23	RMOH300-N2-0
- USB with DV-Win PC software - Ground (PE) cable - Carrying belts - Plastic transport case – medium size	
Power supply adapter 3 A EU	PWR-ADP3A-EU

Recommended accessories	**Article No**
Current and sense cables 5 m with TTA clamps (100 A rated) ***for RMO-H21***	CS-05-06CLWC
Current and sense cables 5 m with TTA clamps (220 A rated) ***for RMO-H22***	CS-05-16CLWC
Current and sense cables 5 m with TTA clamps (300 A rated) ***for RMO-H23***	CS-05-25CLWC

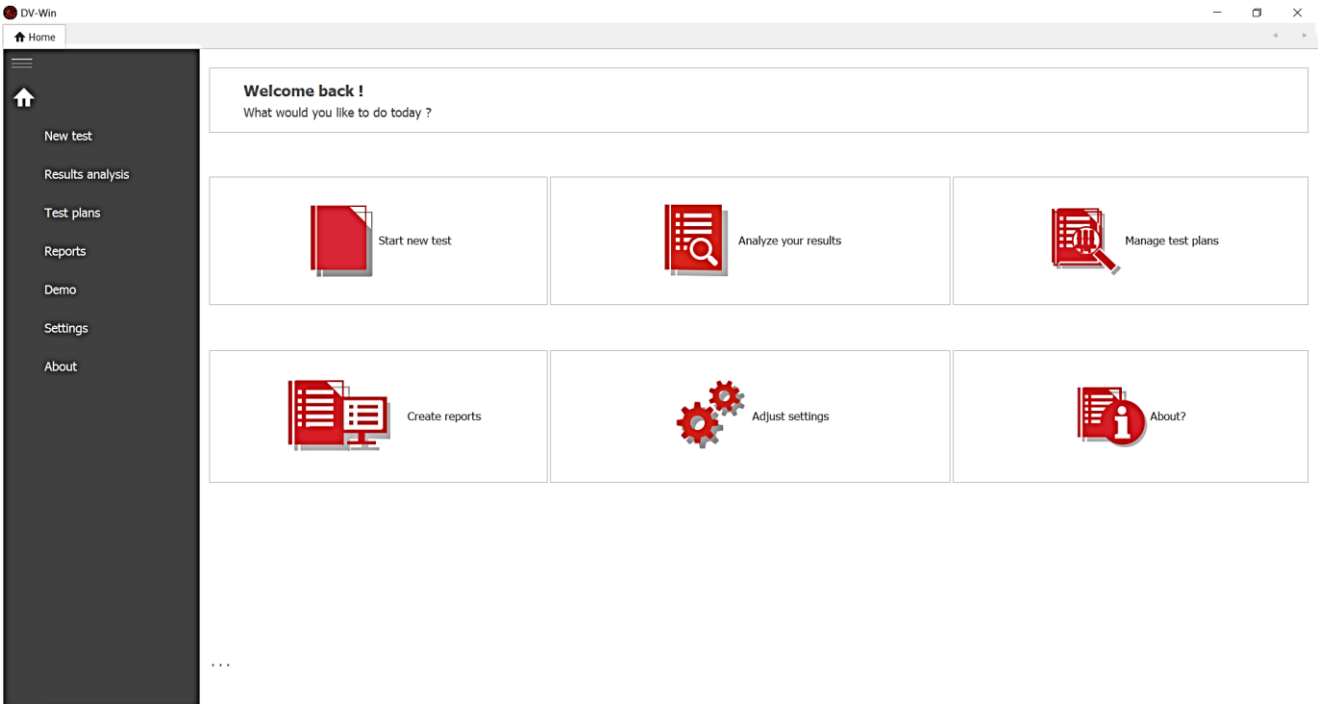
Optional accessories	**Article No**
Current and sense cables 2 x 5 m with Kelvin probes (220 A rated)	CS2-05-16CLKP
Current and sense cables 2 x 5 m with Kelvin probes (300 A rated)	CS2-05-25CLKP
Current and sense cables 10 m with TTA clamps (100 A rated)	CS-10-10CLWC
Current and sense cables 10 m with TTA clamps (220 A rated)	CS-10-25CLWC
Current and sense cables 15 m with TTA clamps (100 A rated)	CS-15-16CLWC
Current cables 2 x 5 m with battery clamps (100 A rated)	C2-05-06CLB1
Current cables 2 x 5 m with battery clamps (220 A rated)	C2-05-16CLB1
Current cables 2 x 5 m with battery clamps (300 A rated)	C2-05-25CLB1
Current cables 2 x 10 m with battery clamps (100 A rated)	C2-10-10CLB1
Current cables 2 x 10 m with battery clamps (220 A rated)	C2-10-25CLB1
Current cables 2 x 15 m with battery clamps (100 A rated)	C2-15-16CLB1
Sense cables 2 x 10 m with alligator clamps (A2)	S2-10-02BPA2
Sense cables 2 x 15 m with alligator clamps (A2)	S2-15-02BPA2
Cable bag	CABLE-BAG-00
Test shunt 240 μΩ (250 A/60 mV)	SHUNT-240-MK
Test shunt 1 mΩ (150 A/150 mV)	SHUNT-150-MK
Power supply adapter (car charger)	PWR-ADP3-CC0

NOTE:
RMO-H21, RMO-H22, RMO-H23 devices DO NOT HAVE interchangeable test leads with RMO-H1, RMO-H2, RMO-H3 models. Any use of non-suitable test leads (not mentioned in accessory list above) will be considered as improper device use and can lead even to the device malfunctioning.

DV-Win software

***included in the purchase price**

DV-Win Software for the RMO-H device is an application set of tools based on the Windows operating system. It enables communication between the RMO-H device and a standard PC over the Bluetooth connection.



- Saving the test results in different formats
- Test reports generating after the test
- Printing and exporting the test reports in different formats
- Several filters for results download to PC

NOTE: In order to connect RMO-H with the PC, Bluetooth communication should be activated in the Settings menu of the device, as well as in the DV-Win (Tools → Communication → Bluetooth)

IBEKO Power AB 2022

Manufacturer
Contact Information

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