

3.10.4 Measurements using AutoISO-1000c



WARNING

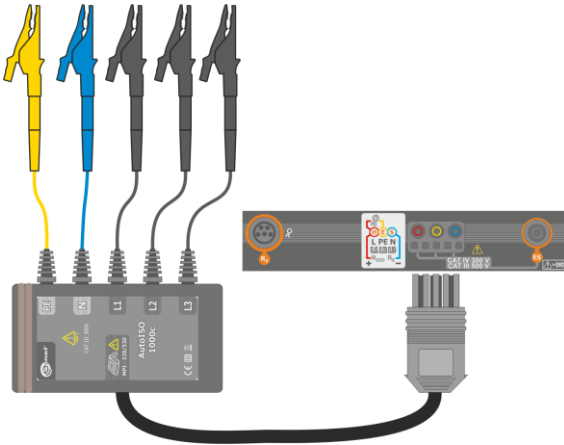
- During measurements of insulation resistance, dangerous voltage up to 1 kV occurs at the ends of test leads of the meter.
- **It is forbidden** to disconnect test leads before the measurement is completed. Failure to obey the above instruction will lead to **electric shock with high voltage** and make it impossible to discharge the tested object.

1



Select item **R_{ISO}**, to call up the measurement screen.

2



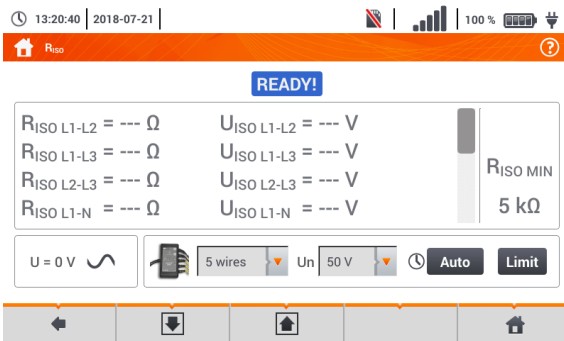
Connect **AutoISO-1000c** adapter.

The meter detects this fact automatically and changes the appearance of the screen.

3

Enter the measurement settings in accordance with **section 3.10.1**.

4



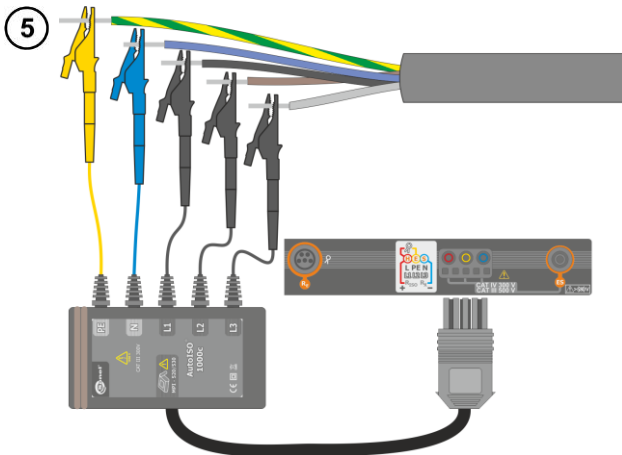
The meter is ready for measurement.

Live mode

U – interference voltage

Description of function icons

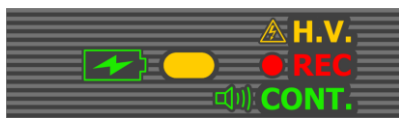
- ▾ scrolling down the list of measurements
- ▴ scrolling up the list of measurements



Connect AutoISO-1000c adapter to the lead tested.



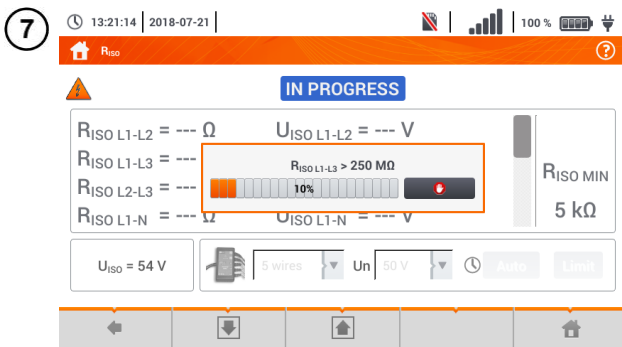
Press **START** to start measurement.



During the measurement the **H.V./REC/CONT.** diode is lit in **orange**.

If any of the voltages exceeds allowable voltage value (50 V), **Object under voltage** message is displayed and the measurement is blocked.


First, checking of voltages on particular pairs of wires is performed. If any of the voltages exceeds allowable voltage, the symbol of this voltage is displayed (e.g. **VOLTAGE! L1PE**), and the measurement is interrupted.



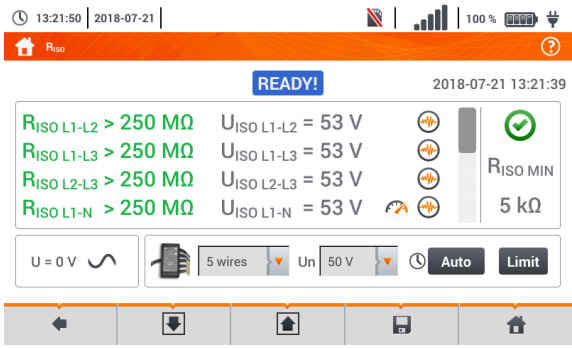
View of the screen during measurement.

The display shows the symbol of the resistance being measured and the progress bar of this measurement.

The bar shows % of progress of total measurement.

The measurement may be cancelled at any time using the  icon.

8



Read out the results.

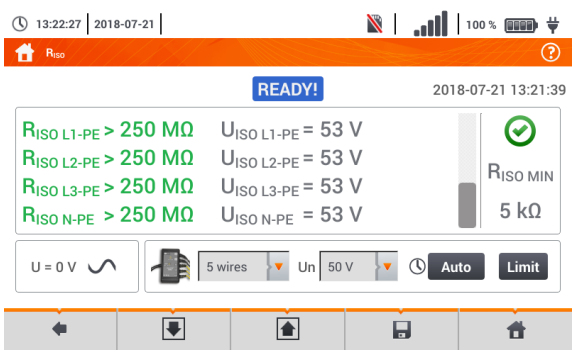
Signal lights for reaching the limit (section 3.7.1 step 4)

- the result is within the set limit
- the result is outside the set limit
- assessment not possible

Additional signal lights for each of the measured lead pairs

- noise – too strong interference signal recorded
- limit – measurement taken at inverter current limit (e.g. short circuit in the test object)

9



Using the slider or icons scroll the screen to read other measurement results.






10

Save the measurement to the meter memory using the icon. A detailed description of memory management is contained in section 5.3. The last measurement can be recalled using the icon.



- The meter emits a continuous audio signal until test voltage reaches 90% of the pre-set value (and also when 110% of the preset value is exceeded).
- After completion of measurement, the capacitance of the object tested is discharged by shorting R_{iso+} and R_{iso-} terminals with resistance of 100 kΩ.

Additional information displayed by the meter

	The meter is ready for measurement.
	Measurement in progress.
	Too high voltage detected on terminals of the meter. Disconnects the terminals from the test object.
	Interference voltage occurs on the tested object. Measurement is possible but may be burdened with additional uncertainty.
	Current limit tripped. The symbol displayed during the measurement is accompanied by a continuous beep. If it is displayed after the measurement, it means that the measurement result was obtained during operation with a current limiting device (e.g. short circuit in the test object).

3.11 Low-voltage resistance measurement

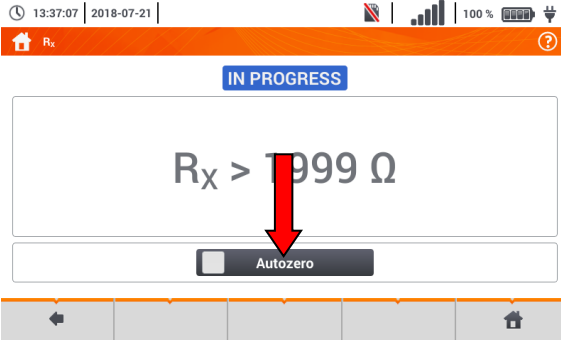
3.11.1 Resistance measurement

1



Select item **R_x**, to call up the measurement screen.

2



Select **Autozero** to eliminate the resistance of test leads.

3



Follow the on-screen prompts.

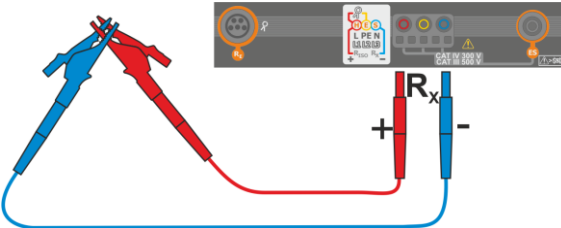
Description of function icons

Yes – accept selection

No – cancels the action

After selecting **Yes** the meter will give the **result reduced** by the resistance of test leads.

4



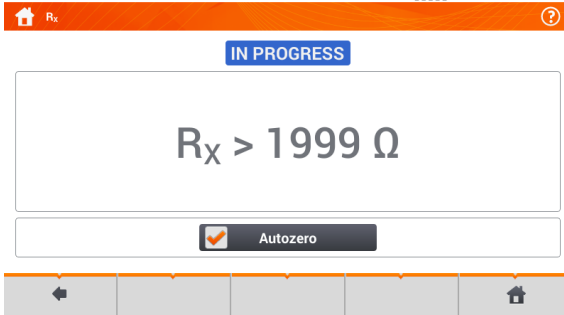
To **disable compensation** of the resistance of leads, repeat steps ②③④ with **open** test leads. Then the measurement result will **contain the resistance of test leads**.

5

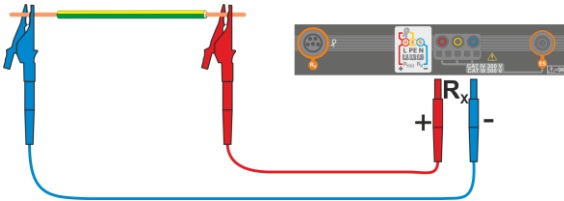
13:41:12 | 2018-07-21



The meter is ready for measurement.

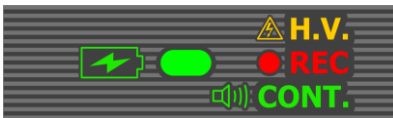


6



• Connect the meter to the tested object.

• Measurement starts automatically.



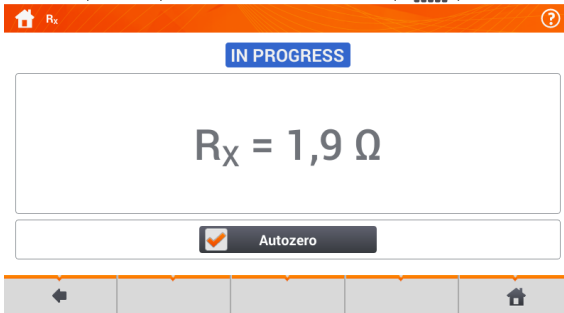
• During the measurement the **H.V./REC/CONT. diode** is lit **green** and a sound signal is emitted.

7


13:41:39 | 2018-07-21



Read out the result.



NOTE!

Display of symbols  **VOLTAGE!** indicates that the tested object is live. The measurement is blocked. The meter must be **immediately disconnected from the object**.



- If the **Autozero** option was **not deselected**, (steps ②③④), the meter invariably **reduces** the measurement result by the resistance of the previously connected test leads. Therefore, for each change of the leads, the **Autozero** procedure must be repeated.
- The correction factor is also remembered after restarting the function and/or the meter.
- If the test leads have been changed to such of a **lower** resistance than the previous ones but the **Autozero** procedure has not been performed, the meter will **understate** the value of the measurement. In extreme cases, the meter may indicate a **negative resistance**. Similarly, **greater** resistance of the leads causes an **overstated** result of the measurements.
- Maximum compensation of test leads resistance (Autozero) equals 500 Ω.

Additional information displayed by the meter

IN PROGRESS

Measurement in progress

VOLTAGE!

Incorrect voltage on object.

NOISE!

Interference voltage occurs on the tested object. The measurement is possible however it will be burdened with additional uncertainty that is specified in the technical data.

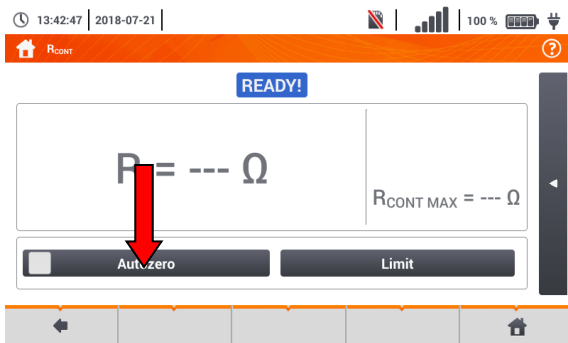
3.11.2 Measurement of resistance of protective conductors and equipotential bonding with ± 200 mA current

1



Select item **R_{CONT}**, to call up the measurement screen.

2



In order to eliminate the impact of the resistance of test leads on measurement result, the compensation (autozeroing) of resistance may be performed. For this purpose, select **Autozero**.

3



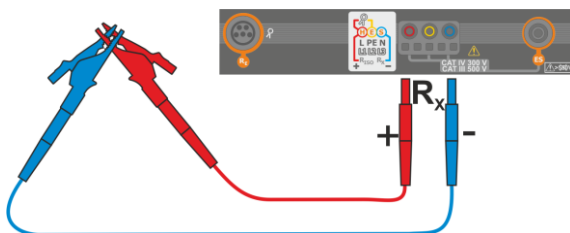
Follow the on-screen prompts.

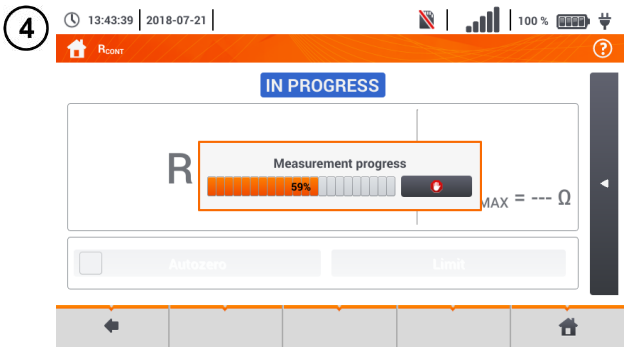
Description of function icons

Yes – accept selection

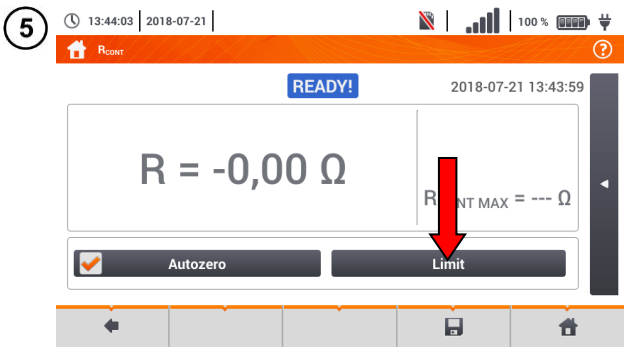
No – cancels the action

After selecting **Yes** the meter will measure resistance of test leads 3 times. Then it will give the **result reduced** by this resistance.





To **disable compensation** of the resistance of leads, repeat steps ② ③ with **open** test leads. Then the measurement result will **contain the resistance of test leads**.





Set the acceptable limit resistance of the measured object.



Using the on-screen keyboard delete the existing value and enter the required one.

Range: 0...400 Ω

Functions of icons

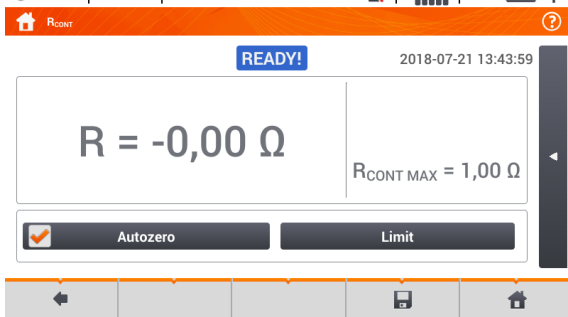
-  reject changes and exit to the previous screen
-  accept changes

7

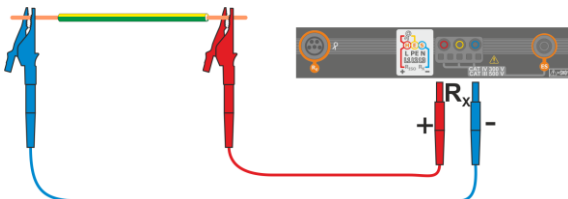
13:44:53 | 2018-07-21



The meter is ready for measurement.



8



- Connect the meter to the tested object.
- Measurement starts automatically.

9

13:46:16 | 2018-07-21



Read the measurement result.



The result is the arithmetic mean of the values of two measurements at a current of 200 mA with opposite polarities R_F and R_R .

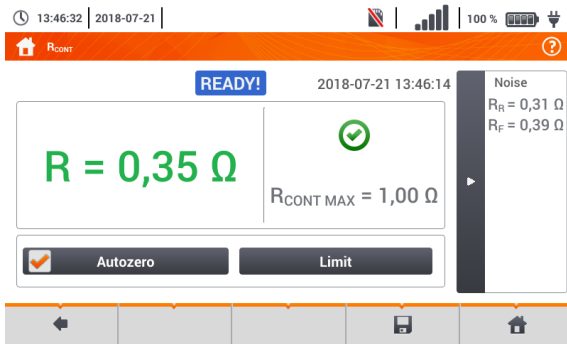
$$R = \frac{R_F + R_R}{2}$$

Signal lights for the limit (step 5).

- ✔ the result is within the set limit
- ✘ the result is outside the set limit
- ⊖ assessment not possible

After selecting the bar ◀ on the right side, a menu will slide out with additional measurement results.


10




R_F – result obtained for a **positive** polarity of the measuring current
 R_R – result obtained for a **negative** polarity of the measuring current

Selecting the  bar hides the menu.

11

Save the measurement to the meter memory using the  icon. A detailed description of memory management is contained in **section 5.3**.

The last measurement can be recalled using the  icon.


12



Press the **START** button in order to start the **next measurement** without disconnecting test leads from the object and proceed to step **(8)**.



NOTE!

Display of symbols  **VOLTAGE!** indicates that the tested object is live. The measurement is blocked. The meter must be **immediately disconnected from the object**.



- If the **Autozero** option was **not deselected**, (steps **(2)(3)(4)**), the meter invariably **reduces** the measurement result by the resistance of the connected test leads. Then, for each change of the leads, the **Autozero** procedure must be repeated.
- The correction factor is also remembered after restarting the function and/or the meter.
- If the test leads have been changed to such of a **lower** resistance than the previous ones but the **Autozero** procedure has not been performed, the meter will **understate** the value of the measurement. In extreme cases, the meter may indicate a **negative resistance**. Similarly, **greater** resistance of the leads causes an **overstated** result of the measurements.
- Maximum compensation of test leads resistance (Autozero) equals 500 Ω.

Additional information displayed by the meter

READY!	The meter is ready for measurement.
IN PROGRESS	Measurement in progress.
VOLTAGE!	Too high voltage on the tested object.
NOISE!	Interference voltage occurs on the tested object. The measurement is possible however it will be burdened with additional uncertainty that is specified in the technical data.

3.12 Phase sequence

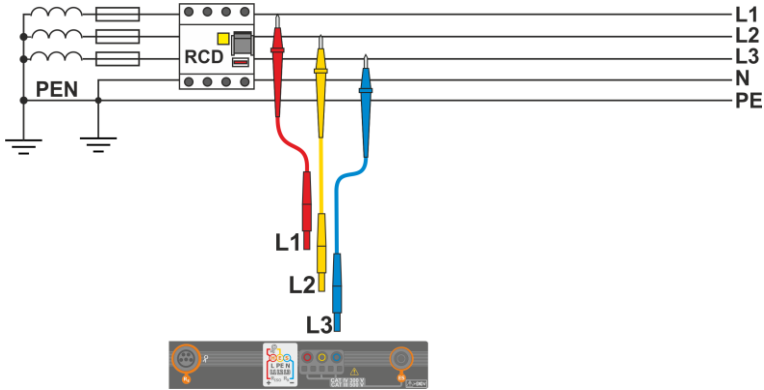
1



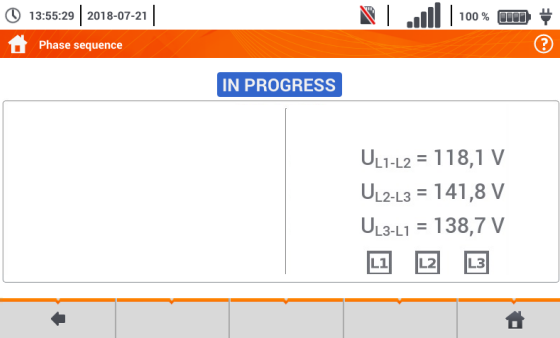
Select item **Phase sequence**, to call up the measurement screen.

2

Connect the meter to the installation according to the drawing.



3



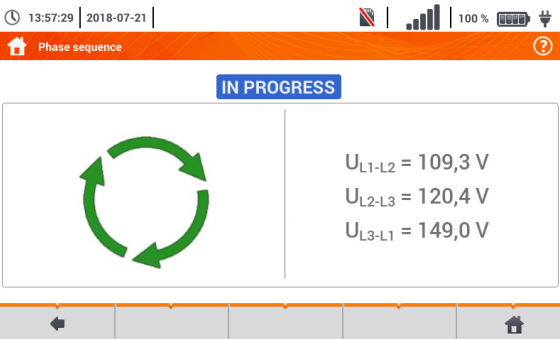
The meter ready for testing.

U_{L1-L2} , U_{L2-L3} , U_{L3-L1}
values of phase-to-phase voltages



signalling the presence of individual phases

4a



The phase sequence is **correct**, i.e. the phase sequence is in **clockwise** direction.

4b

13:58:39 | 2018-07-21 |

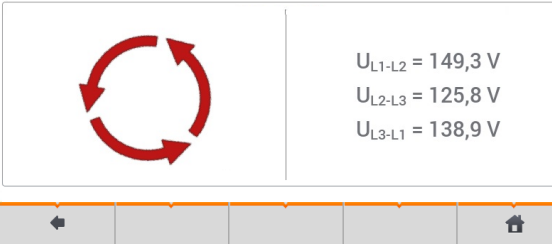


Phase sequence



The phase sequence is **incorrect**, i.e. the phase sequence is in **anticlockwise** direction.

IN PROGRESS



3.13 Motor rotation direction

1



Select item **Motor rotations**, to call up the measurement screen.

2

14:03:12 | 2018-07-21 |

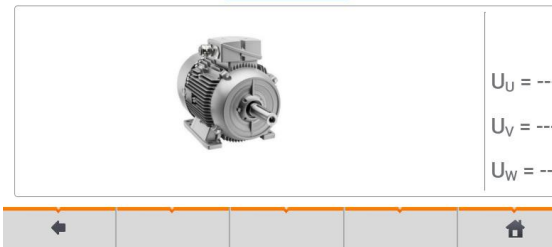


Engine spin

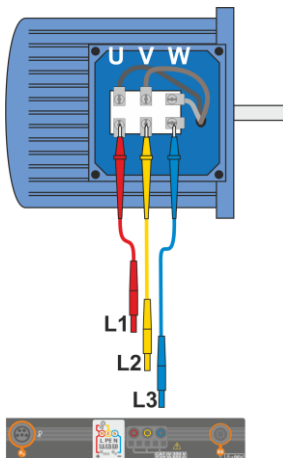


The meter ready for testing.

IN PROGRESS



3



- Connect the meter to the motor according to the drawing, i.e. U terminal do input L1, V to L2, W to L3.
- Vigorously rotate the motor shaft to the right.

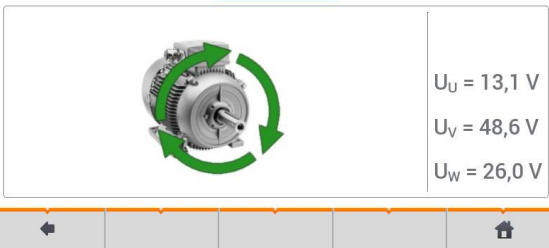
4a

14:03:18 | 2018-07-21



Engine spin

IN PROGRESS



Arrows on the screen rotating **to the right** mean that the motor connected to a 3-phase network will rotate the shaft **to the right**.

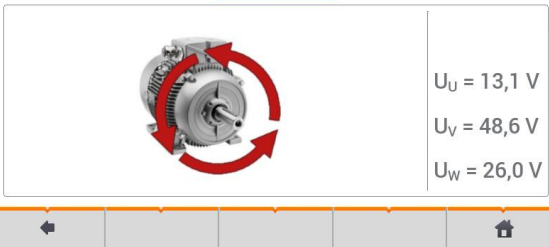
4b

14:08:12 | 2018-07-21



Engine spin

IN PROGRESS



Arrows on the screen rotating **to the left** mean that the motor connected to a 3-phase network will rotate the shaft **to the left**.



- Do not move the test leads during the test.
- Moving disconnected test leads, may induce voltages that result in indicating the direction of rotation.

3.14 Illuminance

1



Select item **Lux** to call up the measurement screen.

2

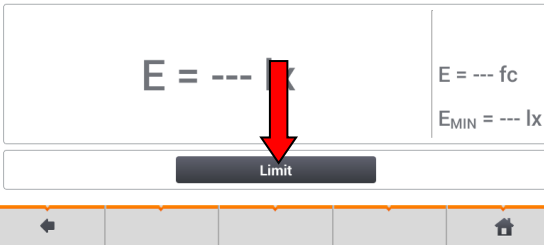


Connect the optical probe.

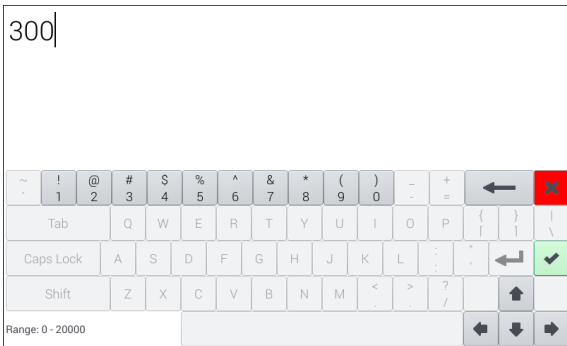
3



Select **Limit** to set the criterion of minimum illuminance.



4



- Select unit.
- Delete the previous value and enter a new one from the range of 0...20 000 lx.

Functions of icons

- reject changes and exit to the previous screen
- accept changes

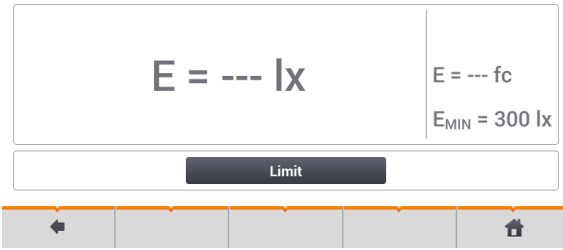
5

14:12:54 | 2018-07-21



Luxmeter

The meter is ready for light measurement.



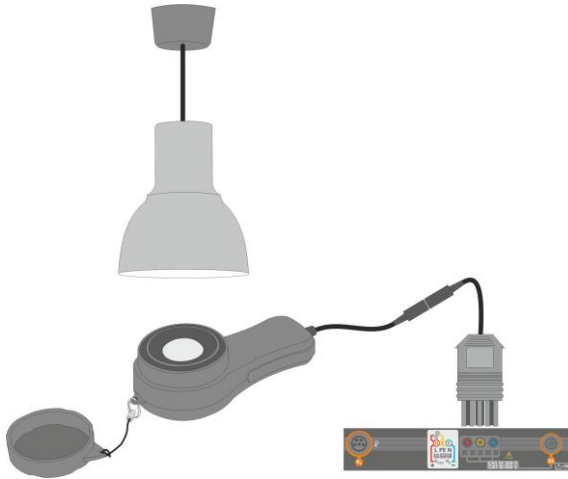
Live mode

E [lx] – illumination expressed in lux (lm/m²)

E [fc] – illumination expressed in lm/ft² (lumen per square foot)

E_{MIN} – limit set in steps (3) (4)

6



Place the probe in the test work plane.

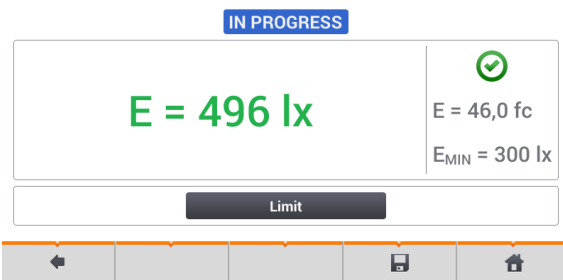
7

14:13:10 | 2018-07-21



Luxmeter

Read out the result.



Signal lights for the limit (step


3)

✔ the result is within the set limit

✘ the result is outside the set limit

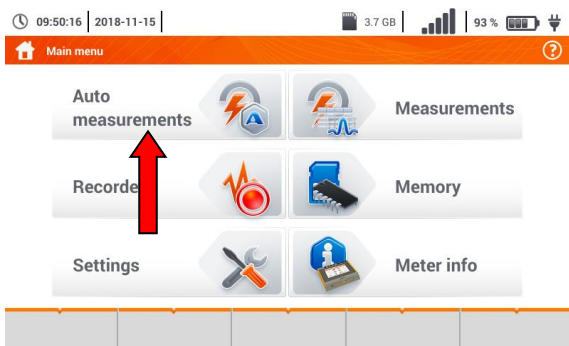
⊖ assessment not possible

8

Save the measurement to the meter memory using the  icon. A detailed description of memory management is contained in **section 5.3**.

4 Auto measurements

The meter includes automated test procedures.



4.1 Proceeding auto measurements

1 The screenshot shows the 'Auto measurements' screen. At the top, there is a status bar with the time 16:07:51, date 2020-03-26, 3.6 GB free, 100% battery, and signal strength. Below this is an orange header with a home icon, 'Auto measurements' text, and a help icon. The main content is a table with two columns: 'Name' and 'Modified'. The table has two rows: 'TN/TT/IT' and 'EVSE'. Each row has a folder icon next to the name.

Name	Modified
TN/TT/IT	2020-03-26 15:35:03
EVSE	2020-03-26 15:35:03

The measurement sequences are grouped into two folders:
 ⇒ measurements in TN/TT/IT networks,
 ⇒ measurements dedicated for electric vehicles charging stations.

Select the measuring sequence from the list.

2 The screenshot shows the configuration screen for 'Auto measurement - Zln+ZlpeRCD'. At the top, there is a status bar with the time 10:04:48, date 2019-10-21, 100% battery, and signal strength. Below this is an orange header with a home icon, 'Auto measurement - Zln+ZlpeRCD' text, and a help icon. The main content is a form with two sections: 'Z_{L-N}' and 'Z_{L-PE/RCD}'. Each section has an 'Accessory' dropdown menu, an 'I_k (Un)' dropdown menu, and an 'I_a' dropdown menu with a 'B10' button. Below the form is a navigation bar with icons for back, forward, save, and home.

Connect the meter to the measuring system.

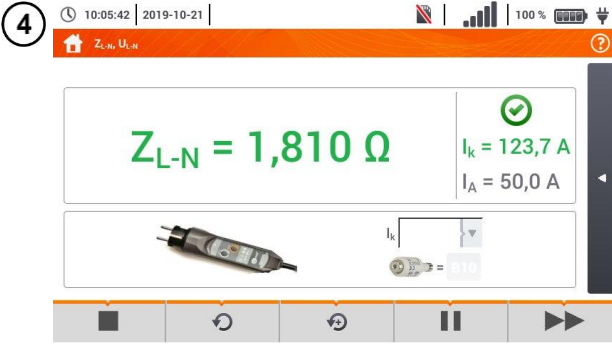
In each setting field, enter the type of measuring accessory, installation parameters and other required data.

Description of function icons

- assistance for a particular measurement
- collapsing setting fields
- expanding setting fields
- saving entered measurement data

Press **START**. The automatic measurement sequence will start.





◀ The screen after completion of one of sequence measurements.

Description of function icons

- stopping the procedure and going to summary
- ↺ repeating the measurement with overwriting its result
- ↻ repeating the measurement without losing its previous result
- ⏸ stopping the procedure
- ▶▶ going to the next step of the procedure or to the summary. Time remaining to the next step is set according to **sec. 2.2.1.**

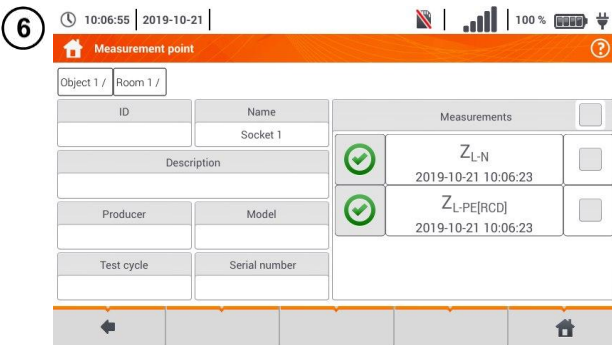


◀ Summary screen.

The procedure can be restarted with the ↺ icon.

Each measurement in a sequence hides partial results. To call them, touch the **label of such measurement**. A window as for a single measurement will be opened. Enter it with the use of the ◀ icon.

Save the measurement to the meter memory using the 📄 icon. A detailed description of memory management is contained in **section 5.3.**



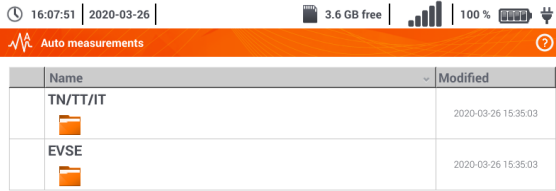
All sequence measurements will be saved in one measuring point.

Signal lights for reaching the limit

- ✓ the result is within the set limit
- ✗ the result is outside the set limit
- ⊖ assessment not possible
- no measurement was made

4.2 Creating measurement procedures

1



- Select **+**, to go to the sequence wizard.

- Select **+**, to add the desired measurement procedure.



2



From the available items select the one, which is to be a part of the procedure. In addition to standard measurements, the following are also available:

- => text message,
- => visual test.

3



After each selection, the menu with step parameters will be shown.

If the tests contain measurements in electric vehicle charging stations, then **EV** box should be selected.

Description of function icons

- assistance for a particular measurement
- collapsing setting fields
- expanding setting fields
- saving entered measurement data

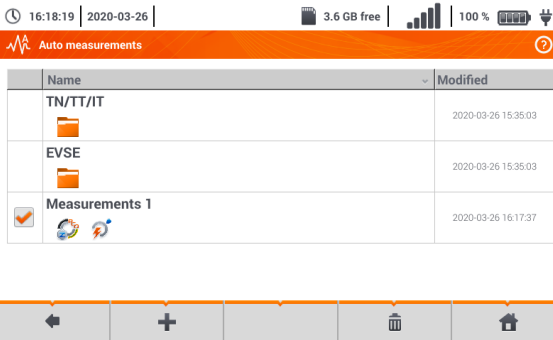
4



Changing the order of the steps is performed by using icons. Delete the step by using icon.

Save the procedure by using icon. A window will be shown requesting the name of the procedure.

5

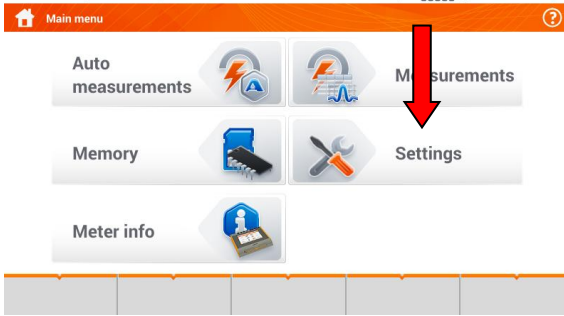


The procedure will be available from the main menu of auto-procedures. To remove it, select it with and choose .

5 Memory of the meter

5.1 Memory settings

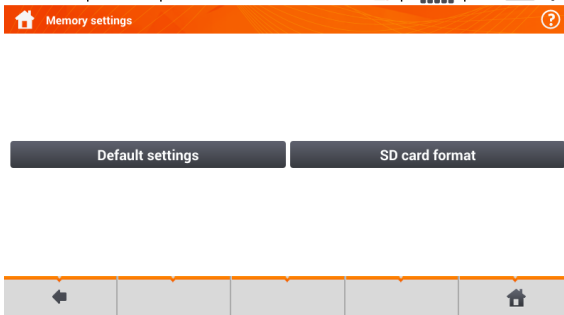
① 14:03:04 | 2018-07-21 | 7.1 GB | 44% | In the main menu select **Settings**.



② **Memory settings** Select **Memory settings**.



③ 13:23:00 | 2018-07-22 | 97% | Two options will appear.



- **Default settings** – restores the meter memory to default memory settings. When this option has been selected, a prompt will appear asking to confirm the selection.

- **SD card format**. When this option has been selected, a prompt will appear asking to confirm that the user wants to format the SD card.

Description of function icons

← return to the previous screen

🏠 return to the main menu

5.2 Structure of the Memory

The memory of measurement results is of a tree structure (**Fig. 5.1**). The user can record an unlimited number of clients. Any number of objects with sub-objects can be created in each client.

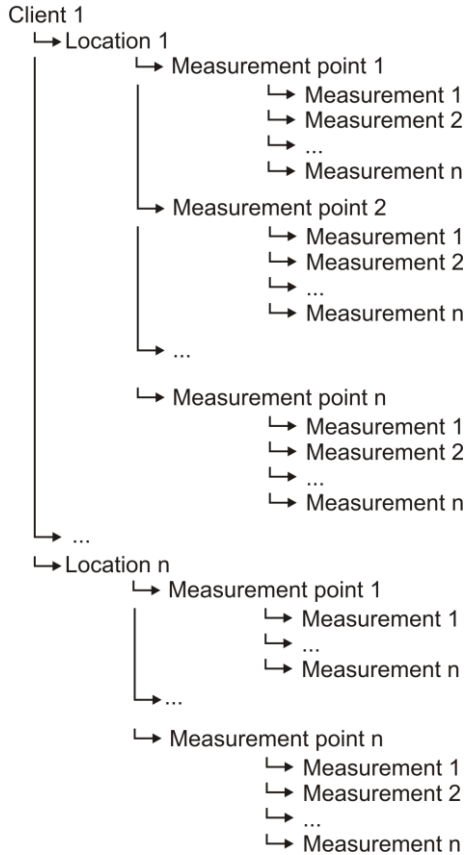


Fig. 5.1. Structure of meter memory for a single client

5.2.1 Fundamentals of navigating the Memory menu

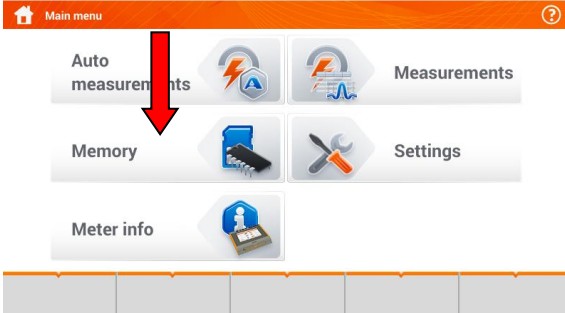
1

14:03:04 | 2018-07-21

7.1 GB

44%

Select **Memory** in the main menu.

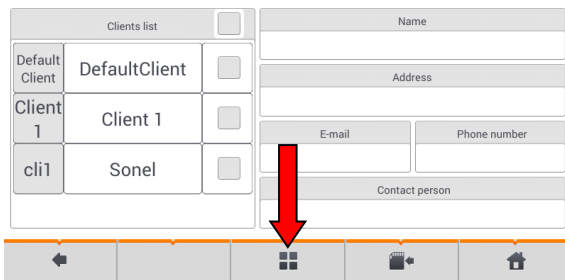


2

13:25:51 | 2018-07-22

98%

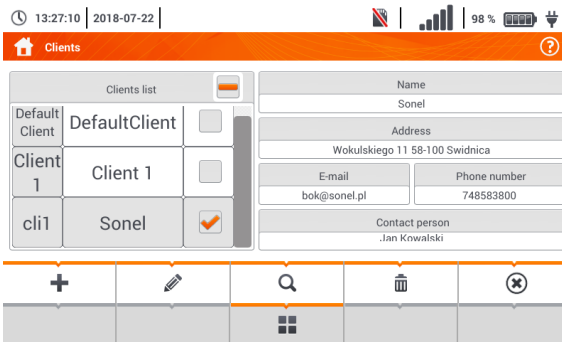
Memory management panel will appear.



Description of function icons

- item inactive
- item active
- ← returning to the previous screen
- ➡ going to a lower level of the active (✓) item
- ✓ going to the folder tree of the active (✓) client
- 🏠 returning to the main menu
- 💾 ← recording the active item to the SD card
- 🗑️ expanding the active item management menu

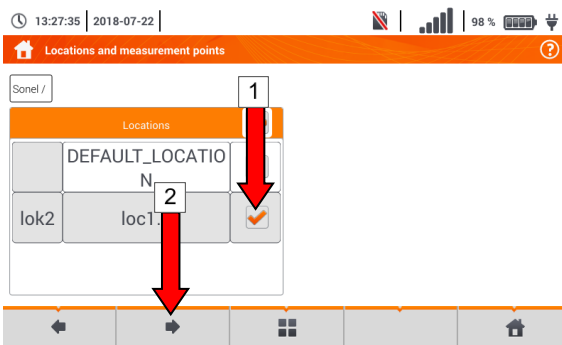
3



Description of icons in the edit menu

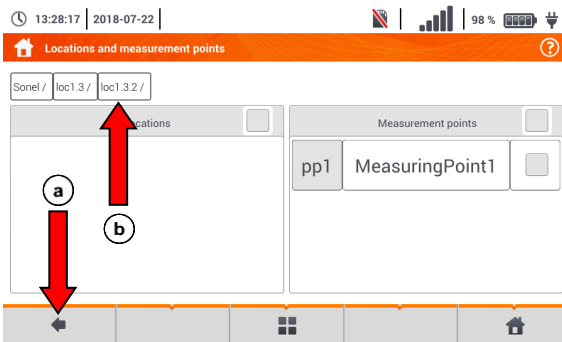
- + adding a new client
- ✎ editing the active client
- 🔍 search mode (**section 5.4**)
- 🗑 removing the active client
- ✕ closing the menu

4



To go to a lower level of the folder tree:

- activate the required item (☐ → ☑),
- select the ➡ icon.

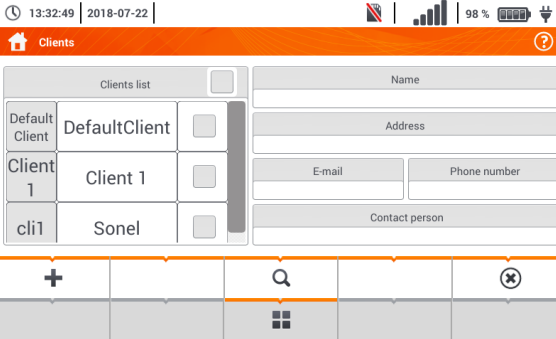


a) To go to a higher level of the folder tree, select the ← icon.

b) To move several levels up, select the name of the required folder on the top navigation bar.

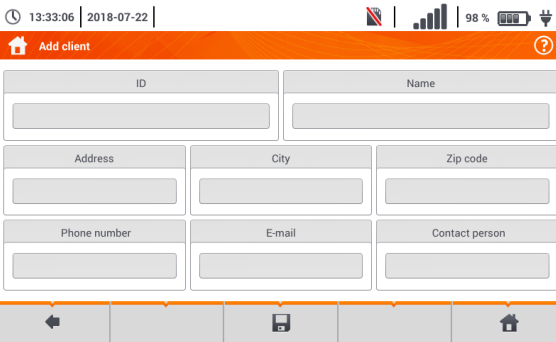
5.2.2 Adding a new measurements tree

1



Add a new client using the + icon.

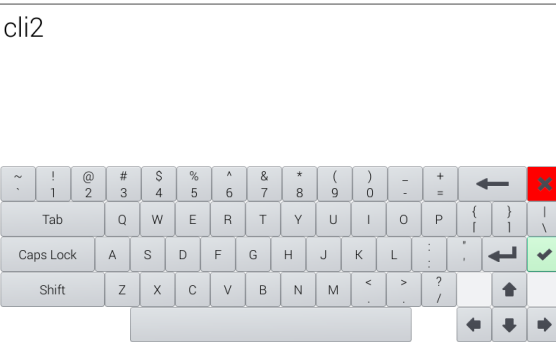
2



Tap and complete the required fields using the on-screen keyboard:

- ⇒ Client ID,
- ⇒ name,
- ⇒ address:
- ⇒ city,
- ⇒ postal code,
- ⇒ phone number,
- ⇒ e-mail,
- ⇒ contact person.

3



Enter the name from the touch keypad (holding certain buttons for a longer time triggers Polish characters).

Functions of icons

- rejecting changes and returning to step 2
- accepting changes and going to step 4


4

13:35:24 | 2018-07-22

Add client

ID	Name	
cli2	Sonel S.A.	
Address	City	Zip code
Wokulskiego 11	Swidnica	58-100
Phone number	E-mail	Contact person
+48748583800	export@sonel.pl	John Smith

← [Save icon] →

- Save changes using the  icon.

- The display will return to the client management menu.

5

13:35:52 | 2018-07-22

Clients

Clients list			Name
Default Client	DefaultClient	<input type="checkbox"/>	Sonel S.A.
Client 1	Client 1	<input type="checkbox"/>	Wokulskiego 11 58-100 Swidnica
cli2	Sonel S.A.	<input checked="" type="checkbox"/>	E-mail: export@sonel.pl Phone number: +48748583800
cli1	Sonel	<input type="checkbox"/>	Contact person: John Smith


← ✓ [Grid icon] [Add icon] →

- Tap to activate the selected client (→)

- Select icon  and  to edit data.

- Further actions are the same as in steps 2, 3, 4.

- To go to the lower level of the tree:

- ⇒ tap the label of the required item,
- ⇒ activate the required item and select .

6

13:36:13 | 2018-07-22

Locations and measurement points

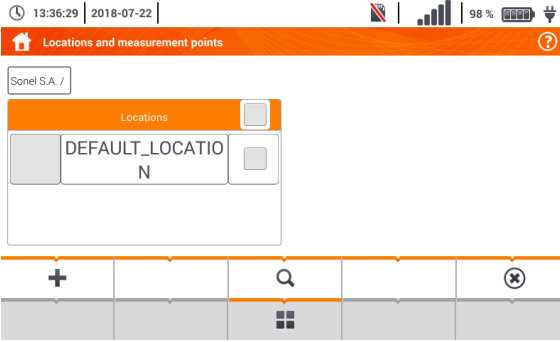
Sonel S.A. /

Locations	
DEFAULT_LOCATIO	<input type="checkbox"/>
N	<input type="checkbox"/>


← [Grid icon] →

Creating a new client results in creating a default location for the measurements.

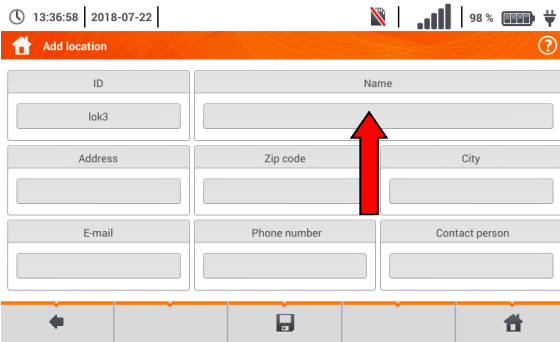
7



To add a new location:

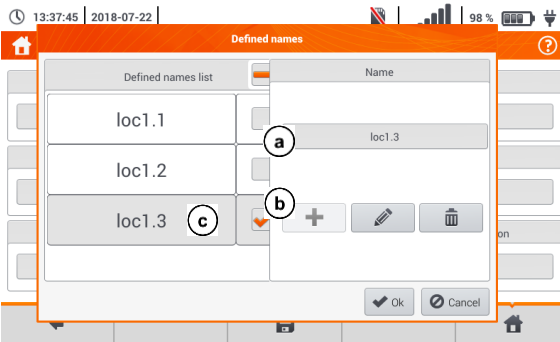
- tap to activate the **Location** column,
- expand the edit menu using the  icon and select **+**,
- proceed as in steps 2 3.



8





In the **Name** field the list of names for further use may be defined.

9




- a Tap the name creation field and add a new name, the same as in step 3.
- b Using the **+** icon add the created item to the list of names.
- c Select the required item and using the icons:
 edit the name,
 remove the name.

Tap to assign a location from the list to a required location of the tree ( → .

Ok – accept all changes.
Cancel – cancel changes.

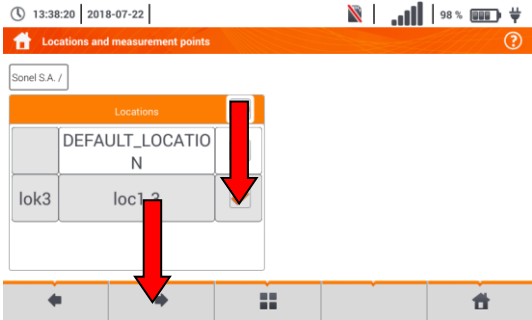
10




- Save changes using the  icon.

- The display will return to the location management menu.

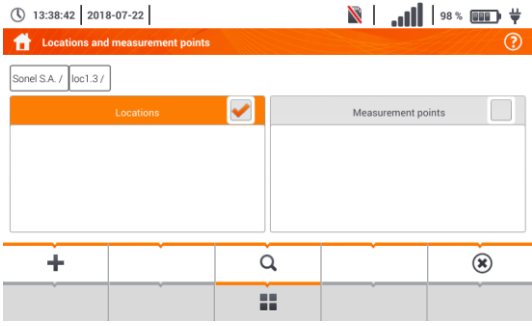
11



- Activate the required location ( → .



- Select  to go to the lower level of the tree.

12



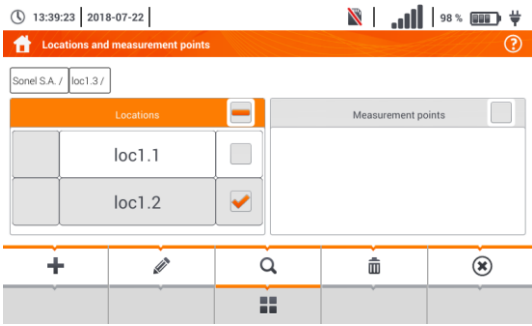
The screen for locations and measuring points will appear.

- Tap to activate the **Location** column.


- Expand the edit menu using the  icon and select .

- Proceed as in steps [\(2\)](#) [\(3\)](#) [\(4\)](#) and [\(8\)](#) [\(9\)](#) [\(10\)](#).


13





- Activate the required location ( → .


- Using the  icon, go to a lower level of the menu.

- If necessary, repeat steps [\(12\)](#) [\(13\)](#).

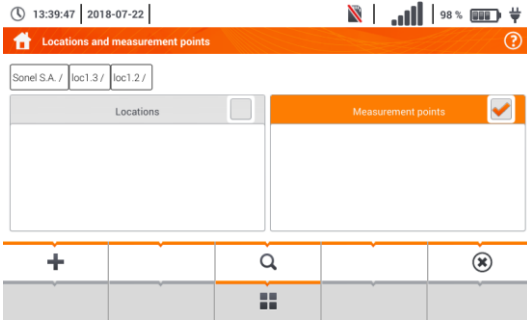
- Using the  icon expand the edit menu and select:

-  to edit location (as in steps [\(8\)](#) [\(9\)](#) [\(10\)](#)),

-  to enter the search mode ([section 5.4](#)),

-  remove.

14



- Activate the column **Measurement points** (☐ → ☑).
- Using the ☐ icon expand the edit menu and select + to add a new measurement point (step 15).

15



Tap and complete the required fields using the on-screen keyboard:

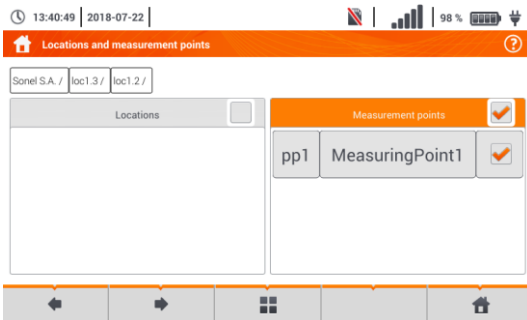
- ⇒ point ID,
- ⇒ name,
- ⇒ description,
- ⇒ manufacturer,
- ⇒ model,
- ⇒ serial number,
- ⇒ measuring cycle,
- ⇒ year of manufacture,
- ⇒ safety class,
- ⇒ nominal voltage,
- ⇒ nominal current,
- ⇒ nominal power.

Description of function icons

- ← returning to the previous screen
- 💾 saving changes
- 🏠 returning to the main menu

The measuring point has been saved.

16



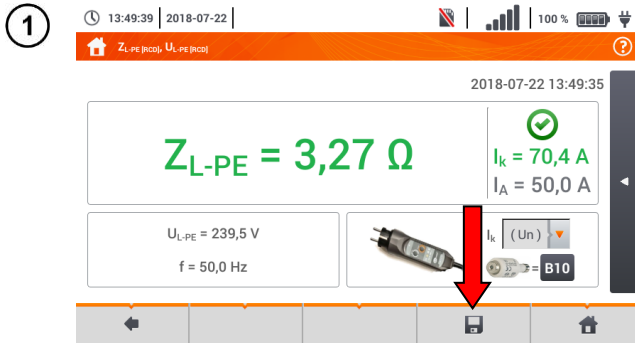
Description of icons in the edit menu


- + adding a new point
- ✎ editing the active point
- Q search mode (section 5.4)
- ✖ removing the active point.
- ☒ closing the menu

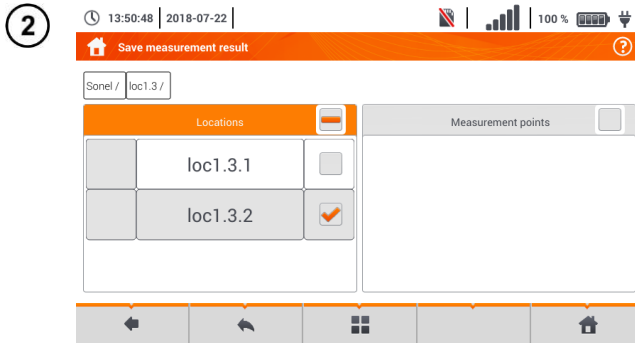


- The results of measurements performed for all measuring functions can be stored in one cell of the **Measurement points** column.
- Only the results of measurements activated by pressing the **START** button can be stored in the memory (except autozeroing in low-voltage measurement of resistance).
- Complete set of results (main result and supplementary results) for a given measuring function, preset measurement settings, date and time of the measurement are stored in the memory.

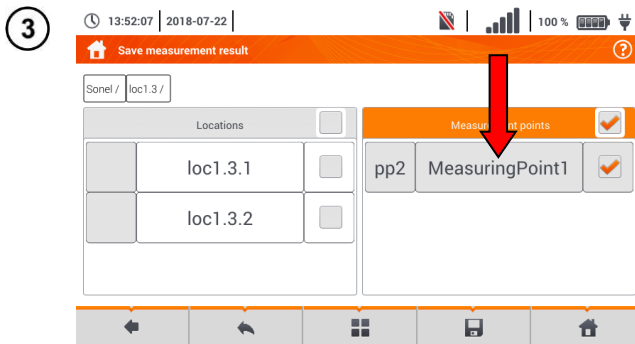
5.3 Entering the measurement result





- After the measurement, select the  icon.
- The menu Entering the measurement result will appear (the menu and control the same as in **section 5.1**).



- If necessary, create a new location in accordance with **section 5.2.2**.



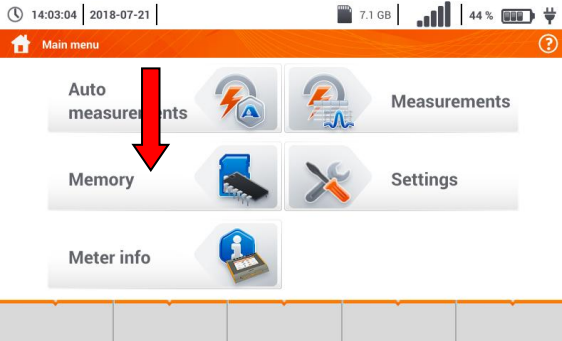
- Select the required measurement point from the location or create a new point in accordance with **section 5.2.2** step (14)(15)(16).
- Tap  to save the result to memory.
- In case of cancellation, return to the measurement menu using the  icon.



Management of objects and sub-objects is possible both in the saving to memory mode and memory viewing (**section 5.4**).

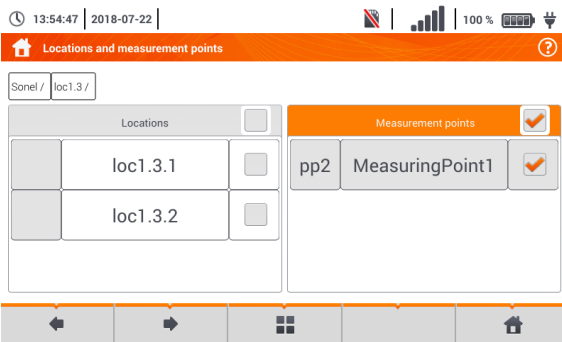
5.4 Viewing saved measurements


1



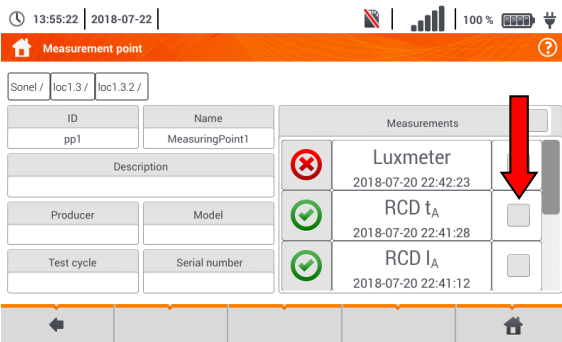
Select **Memory**.

2






- Go to a location with a measuring point to which the measurement results were saved.
- Activate the required measuring point (→)
- Using the  icon, go to the contents of the measuring point.

3



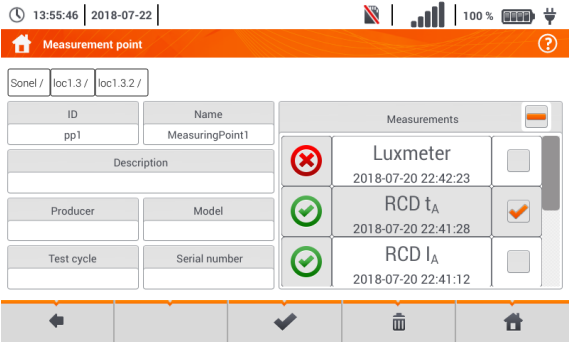
The list of measuring points contained in the active point will be displayed.

Description of controls signalling that the set limit has been reached.

-  condition fulfilled
-  condition unfulfilled
-  limit not defined

To call up the measurements management menu, activate the required records (→)

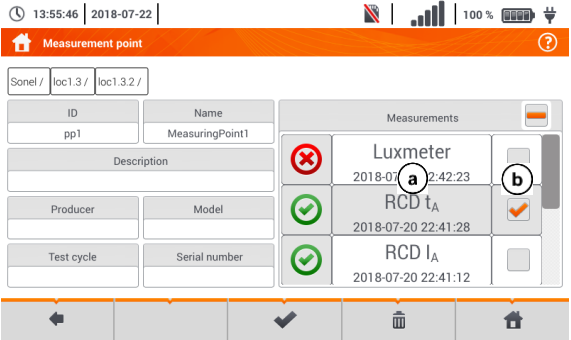
4



Description of function icons

- returning to the previous screen
- going to details (step 5)
- removing the active record.
- returning to the main menu

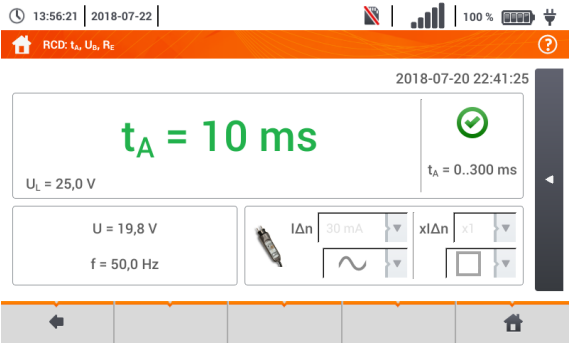
5



To go to the selected measurement result:

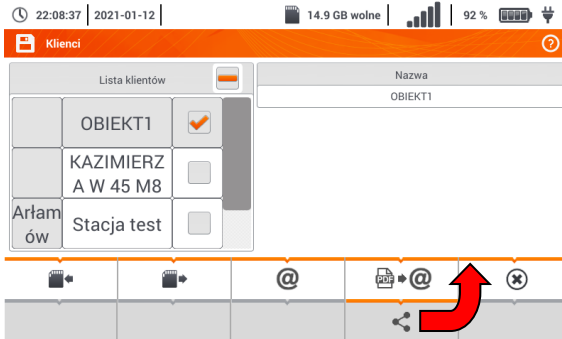
- a tap the record label,
- b activate the record (→) and select .









6



The value of the required measurement will be displayed.

5.5 Sharing recorded measurements



- Select . The following options are available:
 -   import of all clients from the memory card to the meter,
 -   export of selected clients to a memory card,
 -  sending selected customers via e-mail,
 -   generating a report in PDF format and sending it by e-mail.

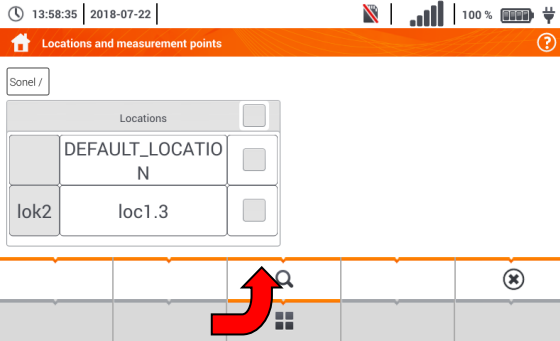
- If necessary, select the customer (→) , which is to be subject to the requested action.
- Select the icon with the desired action.



Before sending data by e-mail, the Outbox must be configured. See **sec. 2.3.3**.

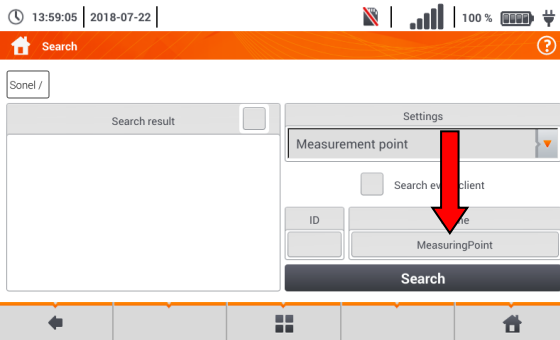
5.6 Searching the meter memory

1



- From anywhere in the browse menu select  and .

2



- The search menu will be displayed.

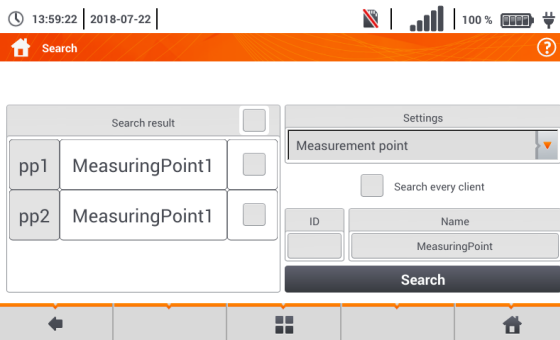
- In the **Settings** field, select the type of the searched object: **location** or **measuring point**.

- If necessary, select **Search all clients** (→ .


- In the **Name** field, enter the searched phrase from the on-screen keyboard.


- Select **Search**.

3





- Activate the required result (→ .

- Go to details using the  icon.

- After the  icon has been selected, the option of record editing is also available in accordance with [section 5.2.2](#), steps [8](#) [9](#) [10](#).

Description of other function icons


-  returning to the previous screen







-  returning to the main menu

6 Power supply

6.1 Monitoring of the battery charge status

The device is equipped with a Li-Ion battery pack 11.1 V 3.4 Ah. The battery pack includes a circuit monitoring its charge status, which provides precise level of battery pack charge and a temperature sensor.

The charging level of the battery pack is indicated by icon on the top bar of the screen on the right side (section 2 element ).

	charging level 80...100%
	charging level 60...80%
	charging level 40...60%
	charging level 20...40%
	charging level 0...20%
	<ul style="list-style-type: none">• batteries fully discharged.• no battery• no communication with the battery pack

6.2 Replacing rechargeable batteries

MPI-535 meter is powered from SONEL Li-Ion rechargeable battery pack.

Battery charger is installed inside the meter and cooperates only with the manufacturer's rechargeable battery pack. The charger is powered by external power supply adapter. It can be also powered from the car cigarette lighter socket. Both the rechargeable battery pack and the adapter are standard components of the meter.



WARNING

If the test leads are left in the terminals during replacement of the batteries, there is a risk of electric shock.

The internal real time clock is supplied from the battery pack, therefore to avoid deleting the clock settings, the battery pack replacement may be performed with connected power supply of 12 V DC.

In order to replace the battery pack it is necessary to:

- remove all the test leads from the sockets and turn the meter off,
- connect the external power supply 12 V DC (to prevent deleting date and time settings)
- remove the four screws of the battery compartment (in the lower part of the casing), **Fig. 6.1**),
- remove the battery compartment,
- remove the compartment cover and remove the batteries,
- insert a new battery pack,
- Insert (snap) the compartment cover,
- Insert the compartment in the meter,
- screw the 4 screws of the battery compartment.

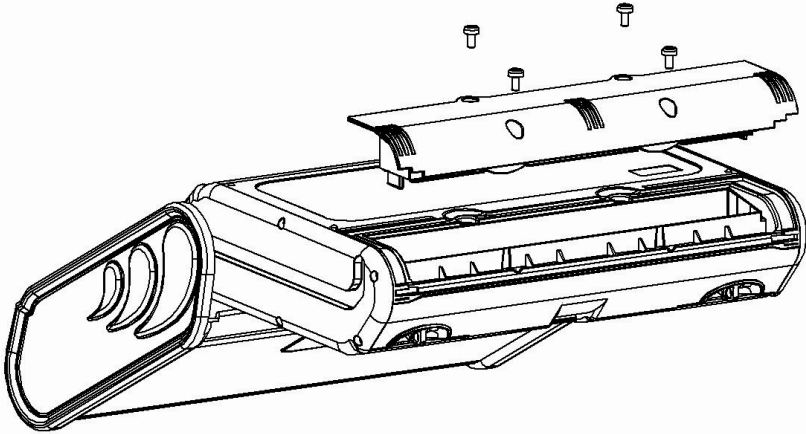


Fig. 6.1. Replacing the battery pack




NOTE!

Do not use the meter when the accumulator compartment is removed or open or power it from other sources than those mentioned in this manual.

6.3 Charging the rechargeable batteries





Charging the battery pack of the device is started automatically after connecting:



- 2 V DC power supply adapter,
- charging cable for the car cigarette lighter.

Charging is indicated by the  icon next to the battery symbol on the top bar and by the **H.V./REC/CONT.** diode. The temperature of the battery and the ambient temperature influence the charging process. If the battery temperature is below 0°C or higher than 45°C, the charging process is stopped.

Indication of charging status

- charging
- damage

- o meter off – diode **H.V./REC/CONT.** is lit **green**  
- o meter on – charging signalled only by an icon on the display  

- o meter off – diode **H.V./REC/CONT.** flashes **green** every 0.5 second 
- o meter on – error signalled by an icon on the display 



Due to interferences in the network or to high ambient temperature, the charging process of rechargeable batteries may finish prematurely. When charging time is too short, turn off the meter and start charging again.

6.4 General rules for using Li-Ion rechargeable batteries

- Store the half-charged battery pack in a plastic container placed in a dry, cool and well ventilated place and protect them from direct sunlight. The battery pack may be damaged if stored when fully discharged. The ambient temperature for prolonged storage should be maintained within the range of 5°C...25°C.
- Charge the batteries in a cool, well-ventilated place at a temperature of 10°C ... 28°C. Modern fast chargers detect both too low and too high temperature of rechargeable batteries and react to the situation adequately. When the temperature is too low, charging should be prevented as it may irreparably damage the batteries. The increase in temperature of the battery pack may cause electrolyte leakage and even its ignition or explosion.
- Do not exceed the charging current, as it may result in ignition or "swelling" of the battery pack. "Swollen" battery pack must not be used.
- Do not charge or use the batteries in extreme temperatures. Extreme temperatures reduce the lifetime of rechargeable batteries. Always observe the rated operating temperature. Do not dispose the battery pack into fire.
- Li-Ion cells are sensitive to mechanical damage. This kind of damage may cause their permanent damage and thus - ignition or explosion.
- Any interference in the structure of Li-ion battery pack may cause its damage. This may result in the ignition or explosion.
- A short-circuit of the battery poles "+" and "-" may permanently damage the battery pack or even cause its fire or explosion.
- Do not immerse Li-Ion battery in liquids and do not store in humid conditions.
- If the electrolyte contained in the Lithium-Ion battery pack, contacts eyes or skin, immediately rinse the affected place with plenty of water and consult a doctor. Protect the battery against unauthorised persons and children.
- When you notice any changes in the Lithium-Ion battery pack (e.g. changes in colour, swelling, excessive temperature), stop using the battery pack. Li-Ion batteries that are mechanically damaged, overcharged or excessively discharged are not suitable for use.
- Any misuse of the battery may cause its permanent damage. This may result in the ignition. The seller and the manufacturer shall not be liable for any damages resulting from improper handling Li-Ion battery pack.

7 Cleaning and maintenance



NOTE!

Use only the maintenance methods specified by the manufacturer in this manual.

The meter has been designed for many years of reliable use, provided that the following recommendations are observed for its maintenance and care:

1. **THE METER MUST BE DRY.** Wipe the dampened meter.
2. **THE METER MUST BE USED AND STORED IN NORMAL TEMPERATURES.** Extreme temperatures may shorten the life of electronic components and distort or melt plastic parts.
3. **THE METER MUST BE HANDLED CAREFULLY AND GENTLY.** Dropping the meter may damage its electronic elements or the housing.
4. **THE METER MUST BE KEPT CLEAN.** From time to time wipe the housing with a damp cloth. DO NOT use chemicals, solvents or detergents.
5. **CLEAN THE PROBES WITH WATER AND DRY THEM** Before the probe is stored for a prolonged period of time it is recommended to grease it with any machine lubricant.
6. The reels and test leads should be cleaned with water and detergents, and then dried.



The electronic system of the meter does not require maintenance.

8 Storage

In the case of storage of the device, the following recommendations must be observed:

- Disconnect all the test leads from the meter.
- Clean the meter and all its accessories thoroughly.
- Wind the long test leads onto the reels.
- In the case the meter is to be stored for a prolonged period of time, the batteries must be removed from the device.
- In order to prevent a total discharge of the rechargeable batteries in the case of a prolonged storage, charge them from time to time.

9 Dismantling and utilisation

Worn-out electric and electronic equipment should be gathered selectively, i.e. it must not be placed with waste of another kind.

Worn-out electronic equipment should be sent to a collection point in accordance with the law of waste electrical and electronic equipment.

Before the equipment is sent to a collection point, do not dismantle any elements. Observe the local regulations concerning disposal of packages and used batteries/rechargeable batteries.

10 Technical data

10.1 Basic data

⇒ Abbreviation "m.v." used in the specification of accuracy means standard measured value

10.1.1 Measurement of alternating voltages (True RMS)

Range	Resolution	Accuracy
0.0 V...299.9 V	0.1 V	±(2% m.v. + 4 digits)
300 V...500 V	1 V	±(2% m.v. + 2 digits)

- Frequency range: 45...65 Hz

10.1.2 Frequency measurement

Range	Resolution	Accuracy
45.0 Hz...65.0 Hz	0.1 Hz	±(0.1% m.v. + 1 digit)

- Voltage range: 50 ... 500V

10.1.3 Measurement of fault loop impedance Z_{L-PE} , Z_{L-N} , Z_{L-L}

Measurement of fault loop impedance Z_s

Test range according to IEC 61557-3:

Test lead	Test range Z_s
1.2 m	0.130 Ω ...1999.9 Ω
5 m	0.170 Ω ...1999.9 Ω
10 m	0.210 Ω ...1999.9 Ω
20 m	0.290 Ω ...1999.9 Ω
WS-03, WS-04	0.190 Ω ...1999.9 Ω

Display range:

Display range	Resolution	Accuracy
0.000...19.999 Ω	0.001 Ω	±(5% m.v. + 0.03 Ω)
20.00...199.99 Ω	0.01 Ω	±(5% m.v. + 0.3 Ω)
200.0...1999.9 Ω	0.1 Ω	±(5% m.v. + 3 Ω)

- Rated operating voltage U_{nL-N} / U_{nL-L} : 110/190 V, 115/200 V, 127/220 V, 220/380 V, 230/400 V, 240/415 V
- Operating voltage range: 95 V...270 V (for Z_{L-PE} and Z_{L-N}) and 95 V...440 V (for Z_{L-L})
- Rated mains frequency f_n : 50 Hz, 60 Hz
- Operating frequency range: 45 Hz...65 Hz
- Maximum test current (for 415 V): 41.5 A (10 ms)
- Control of correctness of PE terminal connection by means of a touch electrode

Indications of fault loop resistance R_s and fault loop reactance X_s

Display range	Resolution	Accuracy
0...19.999 Ω	0.001 Ω	±(5% + 0.05 Ω) of Z_s value

- Calculated and displayed for $Z_s < 20 \Omega$

Indications of short-circuit current I_k

Test range according to IEC 61557-3 can be calculated on the basis of test ranges for Z_s and nominal voltages.

Display range	Resolution	Accuracy
0.055 ... 1.999 A	0.001 A	Calculated on the basis of accuracy for fault loop
2.00... 19.99 A	0.01 A	
20.0... 199.9 A	0.1 A	
200... 1999 A	1 A	
2.00... 19.99 kA	0.01 kA	
20.0 ... 40.0 kA	0.1 kA	

- Prospective fault current calculated and displayed by the meter may slightly differ from the value calculated by the user with a calculator, basing on the displayed value of the impedance, because the meter calculates the current from unrounded value of fault loop impedance (which is used for displaying). As the correct value, consider I_k current value, displayed by the meter or by firmware.

10.1.4 Measurement of fault loop impedance $Z_{L-PE[RCD]}$ (without triggering of RCD)

Measurement of fault loop impedance Z_s

Test range according to IEC 61557-3:

- 0.50... 1999 Ω for 1.2 m leads, WS-03 and WS-04
- 0.51... 1999 Ω for 5 m, 10 m and 20 m leads

Display range	Resolution	Accuracy
0... 19.99 Ω	0.01 Ω	$\pm(6\% \text{ m.v.} + 10 \text{ digits})$
20.0... 199.9 Ω	0.1 Ω	$\pm(6\% \text{ m.v.} + 5 \text{ digits})$
200... 1999 Ω	1 Ω	

- It will not trip RCDs of $I_{\Delta n} \geq 30 \text{ mA}$
- Rated operating voltage U_n : 110 V, 115 V, 127 V, 220 V, 230 V, 240 V
- Operating voltage range: 95 V... 270 V
- Rated mains frequency f_n : 50 Hz, 60 Hz
- Operating frequency range: 45... 65 Hz
- Control of correctness of PE terminal connection by means of a touch electrode

Indications of fault loop resistance R_s and fault loop reactance X_s

Display range	Resolution	Accuracy
0.. 19.99 Ω	0.01 Ω	$\pm(6\% + 10 \text{ digits})$ of Z_s value

- Calculated and displayed for $Z_s < 20 \Omega$

Indications of short-circuit current I_k

Test range according to IEC 61557-3 can be calculated on the basis of test ranges for Z_s and nominal voltages.

Display range	Resolution	Accuracy
0.055 ... 1.999 A	0.001 A	Calculated on the basis of accuracy for fault loop
2.00...19.99 A	0.01 A	
20.0...199.9 A	0.1 A	
200...1999 A	1 A	
2.00...19.99 kA	0.01 kA	
20.0 ...40.0 kA	0.1 kA	

- Prospective fault current calculated and displayed by the meter may slightly differ from the value calculated by the user with a calculator, basing on the displayed value of the impedance, because the meter calculates the current from unrounded value of fault loop impedance (which is used for displaying). As the correct value, consider I_k current value, displayed by the meter or by firmware.

10.1.5 Measurement of parameters of RCD

- Measurement of RCDs type: AC, A, B, B+, F, EV
- Rated operating voltage U_n : 110 V, 115 V, 127 V, 220 V, 230 V, 240 V
- Operating voltage range: 95 V...270 V
- Rated mains frequency f_n : 50 Hz, 60 Hz
- Operating frequency range: 45...65 Hz

RCD trigger and response time test t_A (for measurement function t_A)

Test range according to IEC 61557-6: 0ms ... to the upper limit of displayed value

Type of RCD	Setting of multiple values	Test range	Resolution	Accuracy
<ul style="list-style-type: none"> • General type • Short-time delay type • AC module in EV type 	0.5 $I_{\Delta n}$	0..300 ms (TN/TT)	1 ms	$\pm(2\% \text{ m.v.} + 2 \text{ digits})^1)$
	1 $I_{\Delta n}$	0..400 ms (IT)		
	2 $I_{\Delta n}$	0..150 ms		
	5 $I_{\Delta n}$	0..40 ms		
Selective	0.5 $I_{\Delta n}$	0..500 ms		
	1 $I_{\Delta n}$			
	2 $I_{\Delta n}$	0..200 ms		
	5 $I_{\Delta n}$	0..150 ms		
<ul style="list-style-type: none"> • EV 6 mA DC • RCM 	1 $I_{\Delta n}$	0.0..10.0 s	0.1 s	$\pm(2\% \text{ m.v.} + 3 \text{ digits})$
	10 $I_{\Delta n}$	0..300 ms	1 ms	
	33 $I_{\Delta n}$ ²⁾	0..100 ms		
	50 $I_{\Delta n}$ ³⁾	0..40 ms		

1) for $I_{\Delta n} = 10 \text{ mA}$ and $0.5 I_{\Delta n}$ accuracy is $\pm(2\% \text{ m.v.} + 3 \text{ digits})$

2) for measurements acc. to IEC 62955









3) for measurements acc. to IEC 62752









- Accuracy of differential current setting:

for $1 \cdot I_{\Delta n}$, $2 \cdot I_{\Delta n}$, $5 \cdot I_{\Delta n}$ 0..8%

for $0.5 \cdot I_{\Delta n}$ -8..0%

Effective value of forced leakage current at measurement of RCD disconnection time (does not apply to RCD EV 6 mA DC and RCM) [mA]

$I_{\Delta n}$	Multiplication factor setting							
	0.5				1			
								
10	5	3.5	3.5	5	10	20	20	20
30	15	10.5	10.5	15	30	42	42	60
100	50	35	35	50	100	140	140	200
300	150	105	105	150	300	420	420	600
500	250	175	175	—	500	700	700	1000*
1000	500	—	—	—	1000	—	—	—

$I_{\Delta n}$	Multiplication factor setting							
	2				5			
								
10	20	40	40	40	50	100	100	100
30	60	84	84	120	150	210	210	300
100	200	280	280	400	500	700	700	1000*
300	600	840	840	—	—	—	—	—
500	1000	—	—	—	—	—	—	—
1000	—	—	—	—	—	—	—	—

* - does not apply to $U_n = 110$ V, 115 V and 127 V and IT network

Effective value of forced leakage current at measurement of RCD disconnection time (applies to RCD EV 6 mA DC and RCM) [mA]

$I_{\Delta n}$	Multiplication factor setting			
	1	10	33	50
6 mA DC acc. to IEC 62955	6	60	200	—
6 mA DC acc. to IEC 62752	6	60	—	300

Measurement of resistance-to-earth R_E (for TT)

Selected nominal current of RCD	Test range	Resolution	Test current	Accuracy
10 mA	0.01...5.00 k Ω	0.01 k Ω	4 mA	0..+10% m.v. ± 8 digits
30 mA	0.01...1.66 k Ω		12 mA	0..+10% m.v. ± 5 digits
100 mA	1...500 Ω	1 Ω	40 mA	0..+5% m.v. ± 5 digits
300 mA	1...166 Ω		120 mA	
500 mA	1...100 Ω		200 mA	
1000 mA	1...50 Ω		400 mA	

Measurement of touch voltage U_B in relation to nominal differential current

Test range according to IEC 61557-6: 10.0 V...99.9 V

Test range	Resolution	Test current	Accuracy
0...9.9 V	0.1 V	0.4 x $I_{\Delta n}$	0%...10% m.v. ± 5 digits
10.0...99.9 V			0%...15% m.v.

Measurement of RCD disconnection current I_A for sinusoidal differential current

Test range according to IEC 61557-6: $(0.3...1.0)I_{\Delta n}$

Selected nominal current of RCD	Test range	Resolution	Test current	Accuracy
10 mA	3.0..10.0 mA	0.1 mA	$0.3 \times I_{\Delta n}..1.0 \times I_{\Delta n}$	$\pm 5\% I_{\Delta n}$
30 mA	9.0 .. 30.0 mA			
100 mA	30..100 mA			
300 mA	90..300 mA	1 mA		
500 mA	150..500 mA			
1000 mA	300..1000 mA			

- it is possible to start the measurement from the positive or the negative half of forced leakage current
- test current duration..... max. 8.8 s

Measurement of RCD disconnection current I_A for differential unidirectional pulsed current and unidirectional pulsed current with 6mA direct current offset

Test range according to IEC 61557-6: $(0.35...1.4)I_{\Delta n}$ for $I_{\Delta n} \geq 30$ mA and $(0.35...2)I_{\Delta n}$ for $I_{\Delta n} = 10$ mA

Selected nominal current of RCD	Test range	Resolution	Test current	Accuracy
10 mA	3.5..20.0 mA	0.1 mA	$0.35 \times I_{\Delta n}..2.0 \times I_{\Delta n}$	$\pm 10\% I_{\Delta n}$
30 mA	10.5..42.0 mA			
100 mA	35..140 mA	1 mA	$0.35 \times I_{\Delta n}..1.4 \times I_{\Delta n}$	
300 mA	105..420 mA			
500 mA	175..700 mA			

- measurement may be performed for positive or negative half-periods of forced leakage current
- test current duration..... max. 8.8 s

Measurement of RCD disconnection current I_A for differential direct current

Test range according to IEC 61557-6: $(0.2...2)I_{\Delta n}$

Selected nominal current of RCD	Test range	Resolution	Current	Accuracy
6 mA ¹⁾	1.0..6.0 mA	0.1 mA	1.0..6.0 mA	$\pm 6\% I_{\Delta n}$
10 mA	2.0..20.0 mA	0.1 mA	$0.2 \times I_{\Delta n}..2.0 \times I_{\Delta n}$	$\pm 10\% I_{\Delta n}$
30 mA	6..60 mA	1 mA		
100 mA	20..200 mA			
300 mA	60..600 mA			
500 mA	100..1000 mA			

- measurement can be performed for positive or negative forced leakage current
- test current duration (does not apply to RCD EV and RCM)..... max. 5.2 s
- ¹⁾ test current duration (applies to RCD EV and RCM)
 - acc. to IEC 62955..... 30 s
 - acc. to IEC 62752..... 40 s

10.1.6 Measurement of resistance-to-earth R_E

Test range according to IEC 61557-5: 0.50 Ω ...1.99 k Ω for test voltage of 50 V and 0.56 Ω ...1.99 k Ω for test voltage of 25 V

Range	Resolution	Accuracy
0.00...0.35 Ω	0.01 Ω	$\pm(2\% \text{ m.v.} + 10 \text{ digits})$
0.35...9.99 Ω	0.01 Ω	$\pm(2\% \text{ m.v.} + 4 \text{ digits})$
10.0...99.9 Ω	0.1 Ω	$\pm(2\% \text{ m.v.} + 3 \text{ digits})$
100...999 Ω	1 Ω	
1.00...1.99 k Ω	0.01 k Ω	

- test voltage: 25 V or 50 V rms
- test current: 20 mA, sinusoidal rms 125 Hz (for $f_n=50$ Hz) and 150 Hz (for $f_n=60$ Hz)
- blocking of measurement at interference voltage of $U_N > 24$ V
- maximum measured voltage of interferences $U_{Nmax}=100$ V
- maximum resistance of auxiliary earth electrodes 50 k Ω

Measurement of resistance of auxiliary earth electrodes R_H , R_S

Display range	Resolution	Accuracy
000...999 Ω	1 Ω	$\pm(5\% (R_S + R_E + R_H) + 3 \text{ digits})$
1.00...9.99 k Ω	0.01 k Ω	
10.0...50.0 k Ω	0.1 k Ω	

Measurement of interference voltages

Internal resistance: approx. 8 M Ω

Range	Resolution	Accuracy
0...100 V	1 V	$\pm(2\% \text{ m.v.} + 3 \text{ digits})$

Selective measurement of earthing with clamps

Range	Resolution	Accuracy *
0.00...0.35 Ω	0.01 Ω	$\pm(8\% \text{ m.v.} + 10 \text{ digits})$
0.35...9.99 Ω	0.01 Ω	$\pm(8\% \text{ m.v.} + 4 \text{ digits})$
10.0...99.9 Ω	0.1 Ω	
100...999 Ω	1 Ω	
1.00...1.99 k Ω	0.01 k Ω	

* – at maximum interference current of 1 A

- Measurement with additional current clamps C-3,
- The range of interference current is up to 9.99 A.

Selective measurement of earthing with two clamps

Range	Resolution	Accuracy *
0.00...0.35 Ω	0.01 Ω	$\pm(10\% \text{ m.v.} + 10 \text{ digits})$
0.35...9.99 Ω	0.01 Ω	$\pm(10\% \text{ m.v.} + 4 \text{ digits})$
10.0...19.9 Ω	0.1 Ω	
20.0...99.9 Ω		$\pm(20\% \text{ m.v.} + 4 \text{ digits})$

* – at maximum interference current of 1 A

- Measurement with transmitting clamps N-1 and receiving clamps C-3.
- The range of interference current is up to 9.99 A.

Measuring soil resistivity (ρ)

Range	Resolution	Accuracy
0.0...99.9 Ω m	0.1 Ω m	Depending on the accuracy of the measurement R_E
100...999 Ω m	1 Ω m	
1.00...9.99 k Ω m	0.01 k Ω m	
10.0...99.9 k Ω m	0.1 k Ω m	

- Measurement with Wenner method,
- Option for setting the distance in meters or feet,
- Selecting a distance: 1 m ... 30 m (1 ft ... 90 ft).

10.1.7 Low-voltage measurement of continuity of circuit and resistance

Measurement of continuity of protective conductors and equipotential bonding with 200 mA \pm current

Measurement range according to IEC 61557-4: 0.12...400 Ω

Range	Resolution	Accuracy
0.00...19.99 Ω	0.01 Ω	$\pm(2\% \text{ m.v.} + 3 \text{ digits})$
20.0...199.9 Ω	0.1 Ω	
200...400 Ω	1 Ω	

- Voltage at open terminals: 4 V...9 V
- Output current at $R < 2 \Omega$: min. 200 mA (I_{sc} : 200 mA...250 mA)
- Compensation of test leads resistance
- Measurements for both current polarizations

Measurement of resistance with low current

Range	Resolution	Accuracy
0.0...199.9 Ω	0.1 Ω	$\pm(3\% \text{ m.v.} + 3 \text{ digits})$
200...1999 Ω	1 Ω	

- Voltage at open terminals: 4 V...9 V
- Output current < 8 mA
- Audio signal for measured resistance < 30 $\Omega \pm 50\%$
- Compensation of test leads resistance

10.1.8 Measurement of insulation resistance

Measurement range, according to IEC 61557-2 for $U_N = 50 \text{ V}$: 50 k Ω ...250 M Ω

Display range for $U_N = 50 \text{ V}$	Resolution	Accuracy
0 k Ω ...1999 k Ω	1 k Ω	$\pm(3\% \text{ m.v.} + 8 \text{ digits})$, $[\pm(5\% \text{ m.v.} + 8 \text{ digits})]^*$
2.00 M Ω ...19.99 M Ω	0.01 M Ω	
20.0 M Ω ...199.9 M Ω	0.1 M Ω	
200 M Ω ...250 M Ω	1 M Ω	

* – for WS-03 and WS-04 leads

Test range according to IEC 61557-2 for $U_N = 100 \text{ V}$: 100 k Ω ...500 M Ω

Display range for $U_N = 100 \text{ V}$	Resolution	Accuracy
0 k Ω ...1999 k Ω	1 k Ω	$\pm(3\% \text{ m.v.} + 8 \text{ digits})$ $[\pm(5\% \text{ m.v.} + 8 \text{ digits})]^*$
2.00 M Ω ...19.99 M Ω	0.01 M Ω	
20.0 M Ω ...199.9 M Ω	0.1 M Ω	
200 M Ω ...500 M Ω	1 M Ω	

* – for WS-03 and WS-04 leads

Test range according to IEC 61557-2 for $U_N = 250 \text{ V}$: 250 k Ω ...999 M Ω

Display range for $U_N = 250 \text{ V}$	Resolution	Accuracy
0 k Ω ...1999 k Ω	1 k Ω	$\pm(3\% \text{ m.v.} + 8 \text{ digits})$ $[\pm(5\% \text{ m.v.} + 8 \text{ digits})]^*$
2.00 M Ω ...19.99 M Ω	0.01 M Ω	
20.0 M Ω ...199.9 M Ω	0.1 M Ω	
200 M Ω ...999 M Ω	1 M Ω	

* – for WS-03 and WS-04 leads

Test range according to IEC 61557-2 for $U_N = 500 \text{ V}$: 500 k Ω ...2.00 G Ω

Display range for $U_N = 500 \text{ V}$	Resolution	Accuracy
0...1999 k Ω	1 k Ω	$\pm(3\% \text{ m.v.} + 8 \text{ digits})$ $[\pm(5\% \text{ m.v.} + 8 \text{ digits})]^*$
2.00...19.99 M Ω	0.01 M Ω	
20.0...199.9 M Ω	0.1 M Ω	
200...999 M Ω	1 M Ω	
1.00...2.00 G Ω	0.01 G Ω	$\pm(4\% \text{ m.v.} + 6 \text{ digits})$ $[\pm(6\% \text{ m.v.} + 6 \text{ digits})]^*$

* – for WS-03 and WS-04 leads

Test range according to IEC 61557-2 for $U_N = 1000 \text{ V}$: 1000 k Ω ...4.99 G Ω

Display range for $U_N = 1000 \text{ V}$	Resolution	Accuracy
0...1999 k Ω	1 k Ω	$\pm(3\% \text{ m.v.} + 8 \text{ digits})$
2.00...19.99 M Ω	0.01 M Ω	
20.0...199.9 M Ω	0.1 M Ω	
200...999 M Ω	1 M Ω	
1.00...4.99 G Ω	0.01 G Ω	$\pm(4\% \text{ m.v.} + 6 \text{ digits})$
5.00...9.99 G Ω	0.01 G Ω	unspecified

- Test voltage: 50 V, 100 V, 250 V, 500 V, 1000 V
- Accuracy of generated voltage (Robc [Ω] $\geq 1000 \cdot U_N$ [V]): -0% + 10% from the set value
- Detection of a dangerous voltage before commencing a measurement

- Discharging the object tested
- Measurement of insulation resistance with the use of UNI-Schuko plug (WS-03, WS-04) between all three terminals (for $U_N=1000\text{ V}$ is not available)
- Insulation resistance measurement for multi-wire cables (max. 5) using an optional external AutoISO-1000c adapter
- Measurement of voltage on terminals $+R_{ISO}$, $-R_{ISO}$ within the range of: $0\text{ V} \dots 440\text{ V}$
- Test current $< 2\text{ mA}$

10.1.9 Light measurements

Measuring ranges of LP-1 probe

Range [lx]	Resolution [lx]	Spectral uncertainty	Accuracy *
0...399.9	0.1	f1<6%	$\pm(5\% \text{ m.v.} + 5 \text{ digits})$
400...3999	1		
4.00 k...19.99 k	0.01 k		

Range [fc]	Resolution [fc]	Spectral uncertainty	Accuracy *
0...39.99	0.01	f1<6%	$\pm(5\% \text{ m.v.} + 5 \text{ digits})$
40.0...399.9	0.1		
400...1999	1		

- Probe class B

* above a reading of 6000 lx / 600 fc, accuracy is not specified

Measuring ranges of LP-10B probe

Range [lx]	Resolution [lx]	Spectral uncertainty	Accuracy
0...39.99	0.01	f1<6%	$\pm(5\% \text{ m.v.} + 5 \text{ digits})$
40.0...399.9	0.1		
400...3999	1		
4.00 k...39.99 k	0.01 k		
40.0 k...399.9 k	0.1 k		

Range [fc]	Resolution [fc]	Spectral uncertainty	Accuracy
0...3.999	0.001	f1<6%	$\pm(5\% \text{ m.v.} + 5 \text{ digits})$
4.00...39.99	0.01		
40.0...399.9	0.1		
400...3999	1		
4.00 k...39.99 k	0.01 k		

- Probe class B

Measuring ranges of LP-10A probe

Range [lx]	Resolution [lx]	Spectral uncertainty	Accuracy
0...3.999	0.001	f1<2%	$\pm(2\% \text{ m.v.} + 5 \text{ digits})$
4.00...39.99	0.01		
40.0...399.9	0.1		
400...3999	1		
4.00 k...39.99 k	0.01 k		
40.0 k...399.9 k	0.1 k		

Range [fc]	Resolution [fc]	Spectral uncertainty	Accuracy
0...3.999	0.001	f1<2%	±(2% m.v. + 5 digits)
4.00...39.99	0.01		
40.0...399.9	0.1		
400...3999	1		
4.00 k...39.99 k	0.01 k		

- Probe class A

10.1.10 Phase sequence

- Phase sequence indication: in the same direction (correct), opposite direction (incorrect)
- Range of network voltages U_{L-L} : 95 V...500 V (45 Hz...65 Hz)
- Display of phase-to-phase voltages

10.1.11 Motor rotation

- EMF motor voltage ranges: 1 V ÷ 500 V AC
- Test current (per phase): <3.5 mA

10.2 Other technical data

- a) type of insulation double, according to EN 61010-1 and IEC 61557
- b) measurement category IV 300 V (III 500 V) according to EN 61010-2-030
- c) housing degree of protection for the housing acc. to EN 60529 IP51 (with closed sealing plug)
- d) meter power supply Li-Ion 11,1 V 3,4 Ah 37,7 Wh
- e) parameters of AC adapter for the battery charge 12 V DC / 2.5 A
 100 V .. 240 V, 50 Hz .. 60 Hz (mains)
- f) dimensions 288 mm x 223 mm x 75 mm
- g) weight of the meter with batteries approx. 2.5 kg
- h) storage temperature -20°C .. +60°C
- i) operating temperature 0°C .. +45°C
- j) temperature range suitable for initiating battery charging +10°C .. +40°C
- k) temperatures at which the charging process is interrupted <+5 °C and ≥ +50°C
- l) humidity 20% .. 90%
- m) reference temperature +23°C ± 2°C
- n) reference humidity 40% .. 60%
- o) altitude (above sea level): <2000 m
- p) time until Auto-OFF 2 min, 5 min or off
- q) number of measurements Z or RCD (for batteries) >3000 (6 measurements/minute)
- r) number of measurements R_{ISO} or R (for charged batteries) >1000
- s) display colour LCD TFT, touchscreen
 800 x 480 pixels
 diagonal 7"
- t) memory of measurement results unlimited
- u) data transmission USB
- v) quality standard design, construction and manufacturing are ISO 9001, ISO 14001, ISO 45001 compliant
- w) the device meets the requirements of standard IEC 61557
- x) the product meets EMC requirements (immunity for industrial environment) according to the following standards EN 61326-1 and EN 61326-2-2



EN 55022 Compliance statement

MPI-535 is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures (e.g. increasing the distance between affected products).



SONEL S.A. hereby declares that the radio device type MPI-535 complies with Directive 2014/53/EU. The full text of the EU Declaration of Conformity is available at the following website address: <https://sonel.pl/en/download/declaration-of-conformity/>

10.3 Bluetooth specification

- a) version v4.2 Classic, BLE
- b) frequency range 2412 MHz .. 2472 MHz
- c) modulation method GFSK/π/4DQPSK/8DPSK/LE
- d) receiver sensitivity down to -92 dBm
- e) maximum radio frequency power (EIRP) 8.3 dBm (ca. 6.8 mW)

10.4 Additional data

Data on additional uncertainties are useful mainly when the meter is used in non-standard conditions and for metrological laboratories for the purpose of calibration.

10.4.1 Additional uncertainties according to IEC 61557-2 (R_{ISO})

Significant parameter	Designation	Additional uncertainty
Position	E ₁	0%
Supply voltage	E ₂	0%
Temperature 0°C...35°C	E ₃	2%

10.4.2 Additional uncertainties according to IEC 61557-3 (Z)

Significant parameter	Designation	Additional uncertainty
Position	E ₁	0%
Supply voltage	E ₂	0%
Temperature 0°C...35°C	E ₃	1.2 m lead – 0 Ω 5 m lead – 0.011 Ω 10 m lead – 0.019 Ω 20 m lead – 0.035 Ω WS-03 and WS-04 lead – 0.15 Ω
Phase angle 0°...30°	E _{6,2}	0.6%
Frequency 99%..101% f _n	E ₇	0%
Mains voltage 85%..110% U _n	E ₈	0%
Harmonic	E ₉	0%
DC component	E ₁₀	0%

10.4.3 Additional uncertainties according to IEC 61557-4 (R ±200 mA)

Significant parameter	Designation	Additional uncertainty
Position	E ₁	0%
Supply voltage	E ₂	0.5%
Temperature 0 °C...35 °C	E ₃	1.5%

10.4.4 Additional uncertainties of earth resistance measurement (R_E)

Additional uncertainties according to IEC 61557-5

Significant parameter	Designation	Additional uncertainty
Position	E ₁	0%
Supply voltage	E ₂	0%
Temperature 0 °C...35 °C	E ₃	0% for 50 V ± 2 digits for 25 V
Serial interference voltage	E ₄	±(6.5% + 5 digits)
Resistance of electrodes	E ₅	2.5%
Frequency 99%... 101% f _n	E ₇	0%
Mains voltage 85%...110% U _n	E ₈	0%

Additional uncertainty caused by serial interference voltage for 3p, 4p, 3p+clamps functions
(for 25 V and 50 V)

R_E	Additional uncertainty
$<10 \Omega$	$\pm(((-32 \cdot 10^{-5} \cdot R_E + 33 \cdot 10^{-4}) \cdot U_Z^2 + (-12 \cdot 10^{-3} \cdot R_E + 13 \cdot 10^{-3}) \cdot U_Z) \cdot 100\% + 0,026 \cdot \sqrt{U_Z \Omega})$
$\geq 10 \Omega$	$\pm(((-46 \cdot 10^{-9} \cdot R_E + 1 \cdot 10^{-4}) \cdot U_Z^2 + (14 \cdot 10^{-8} \cdot R_E + 19 \cdot 10^{-5}) \cdot U_Z) \cdot 100\% + 0,26 \sqrt{U_Z \Omega})$

Additional uncertainty caused by resistance of electrodes

$$\delta_{\text{dod}} = \pm \left(\frac{R_S}{R_S + 10^6} \cdot 300 + \frac{R_H^2}{R_E \cdot R_H + 200} \cdot 3 \cdot 10^{-3} + \left(1 + \frac{1}{R_E} \right) \cdot R_H \cdot 5 \cdot 10^{-4} \right) [\%]$$

Formula is valid for $R_S > 200 \Omega$ and/or $R_H \geq 200 \Omega$.

Additional uncertainty due to interference current for 3p + clamps function
(for 25 V and 50 V)

R_E	Uncertainty [Ω]
$\leq 50 \Omega$	$\pm (4 \cdot 10^{-2} \cdot R_E \cdot I_{\text{zakl}}^2)$
$> 50 \Omega$	$\pm (25 \cdot 10^{-5} \cdot R_E^2 \cdot I_{\text{zakl}}^2)$

Additional uncertainty due to interference current for double clamps function

R_E	Uncertainty [Ω]
$< 5 \Omega$	$\pm (5 \cdot 10^{-2} \cdot R_E^2 \cdot I_{\text{zakl}})$
$\geq 5 \Omega$	$\pm (2,5 \cdot 10^{-2} \cdot R_E^2 \cdot I_{\text{zakl}}^2)$

Additional uncertainty for the ratio of the resistance measured with clamps on a branch of a multiple earthing, to the resultant resistance the as a function of 3p + clamps.

R_C	Uncertainty [Ω]
$\leq 99.9 \Omega$	$\pm (5 \cdot 10^{-3} \cdot \frac{R_C}{R_W})$
$> 99.9 \Omega$	$\pm (9 \cdot 10^{-2} \cdot \frac{R_C}{R_W})$

$R_C[\Omega]$ is a value of resistance measured with clamps on the branch displayed by the device, whereas $R_W[\Omega]$ is a value of resultant resistance of multiply earthing.

10.4.5 Additional uncertainties according to IEC 61557-6 (RCD)

I_A, t_A, U_B



Significant parameter	Designation	Additional uncertainty
Position	E_1	0%
Supply voltage	E_2	0%
Temperature $0^\circ\text{C} \dots 35^\circ\text{C}$	E_3	0%
Resistance of electrodes	E_5	0%
Mains voltage 85%...110% U_n	E_8	0%

10.5 List of reference standards

- EN 61010-1:2010
- EN 61010-2-030:2010
- EN 61557-1:2007,-2, 3, 4, 5, 7:2007, -6:2007, -10:2013
- EN 60529:1991/A2:2013
- EN 61326-1:2013
- EN 61326-2-2:2013
- IEC 62752
- IEC 62955

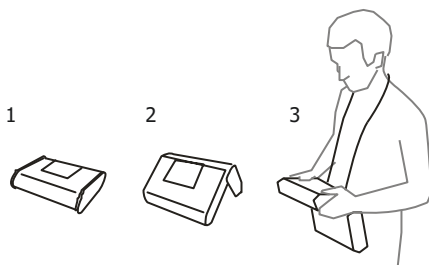
11 Accessories

The full list of accessories can be found on the manufacturer's website.

	 N-1	 C-3
	WACEGN1BB	WACEGC30KR
Rated current	1000 A AC	1000 A AC
Frequency	30 Hz...5 kHz	30 Hz...5 kHz
Max. diameter of measured conductor	52 mm	52 mm
Minimum accuracy	—	≤0.3%
Battery power	—	—
Lead length	2 m	2 m
Measurement category	III 600 V	III 600 V
Ingress protection	IP40	

12 Positions of the meter's cover

The movable cover enables using the meter in various positions.



1 – Cover as the bottom of the meter

2 – Cover used as a support

3 – Cover in the position that enables convenient use of the meter suspended on the neck by means of hanging straps

13 Manufacturer

The manufacturer of the device and provider of guarantee and post-guarantee service:

SONEL S.A.
Wokulskiego 11
58-100 Świdnica
Poland
tel. +48 74 884 10 53 (Customer Service)
e-mail: customerservice@sonel.com
web page: www.sonel.com



NOTE!

Service repairs must be performed only by the manufacturer.

NOTES

MEASURING MESSAGES



NOTE!

The meter is designed for operation at rated phase voltages of 110 V, 115 V, 127 V, 220 V, 230 V and 240 V and phase-to-phase voltages of 190 V, 200 V, 220 V, 380 V, 400 V, 415 V.

Connecting voltage higher than allowed between any of the test terminals may damage the meter and cause a hazard to the user.

Measurement Z_s

L-N!

U_{L-N} voltage is incorrect for making a measurement.

L-PE!

U_{L-PE} voltage is incorrect for making a measurement.

N-PE!

U_{N-PE} voltage exceeds allowable value of 50 V.



Phase connected to N terminal instead of L terminal (for example, exchange of L and N in the mains socket).

TEMPERATURE!

Maximum temperature of the meter is exceeded.

f!

Network frequency is outside the range of 45 Hz...65 Hz.

ERROR!

Measurement error. Correct result cannot be displayed.

Loop circuit malfunction!

The meter should be serviced.

U>500V!

and continuous audio signal

Before measurement, voltage at test terminals exceeds 500 V.

VOLTAGE!

The voltage on the tested object is not within the limits specified for the set rated voltage of the network U_n .

LIMIT!

Too low value of the prospective short circuit current I_k for the pre-set fuse and time of its triggering.

R_E measurement

VOLTAGE!

Too high voltage at the meter terminals.

H!

Interruption in the test probe circuit.

S!

Interruption in the voltage probe circuit.

$R_E > 1.99 \text{ k}\Omega$

Measuring range is exceeded.

NOISE!

Signal / noise ratio is too low (interfering signal too large).

LIMIT!

Measurement uncertainty R_E due to the resistance of electrodes $> 30\%$. (For calculating uncertainty, measured values are taken into account).



Interruption in measuring circuit or resistance of test probes is higher than 60 k Ω .

RCD measurement

$U_B > U_L!$

The touch voltage exceeds a preset U_L threshold value.

!

displayed on the right side of the result indicates a fault of RCD.

PE!

and continuous audio signal

Voltages between the contact electrode and PE conductor exceeds the allowable limit value of U_L .

R_{ISO} measurement



and continuous audio signal

Voltage detected on terminals of the meter. Measurement is not possible.

NOISE!

Interference voltage occurs on the tested object. Measurement is possible but may be burdened with additional uncertainty.

LIMIT!

Current limit tripped. The symbol displayed during the measurement is accompanied by a continuous beep. If it is displayed after the measurement, it means that the measurement result was obtained during operation with a current limiting device (e.g. short circuit of the test object).



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