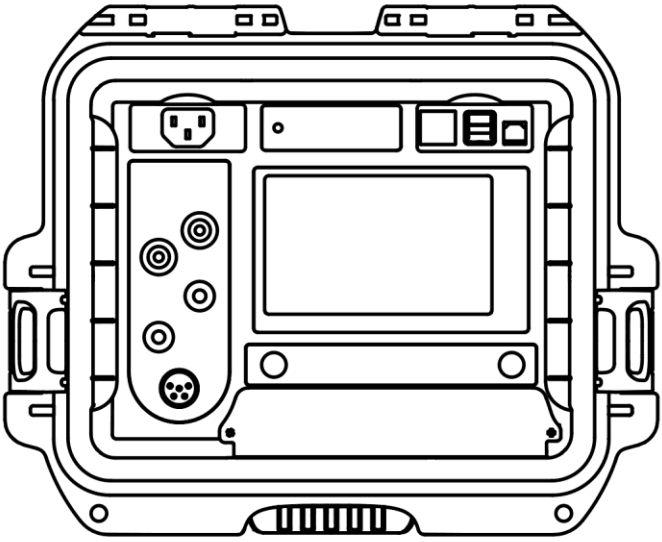
Sonel®



USER MANUAL

LOW RESISTANCE METER

MMR-650

MMR-650

Power socket
Measurement terminal I_2
Measurement terminal I_1
Measurement terminal U_2
Measurement terminal U_1
Temperature probe socket
CAT III 600 V
MMR-650
TEMP
▪ LAN socket
▪ Dual USB A socket for connecting printer and/or USB memory
▪ USB socket (type B) for connecting to a PC
Touch screen
Meter power supply on/off button
Rechargeable batteries compartment
Measurement start/stop button

LOW RESISTANCE METER

MMR-650

USER MANUAL

SONEL S.A.
Wokulskiego 11
58-100 Świdnica
Poland

Version 1.12 05.07.2023

Thank you for purchasing our low-resistance meter. MMR-650 is a modern, high-quality measuring device, which is easy and safe to use. Please acquaint yourself with this manual in order to avoid measuring errors and prevent possible problems in operation of the meter.

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1 Safety

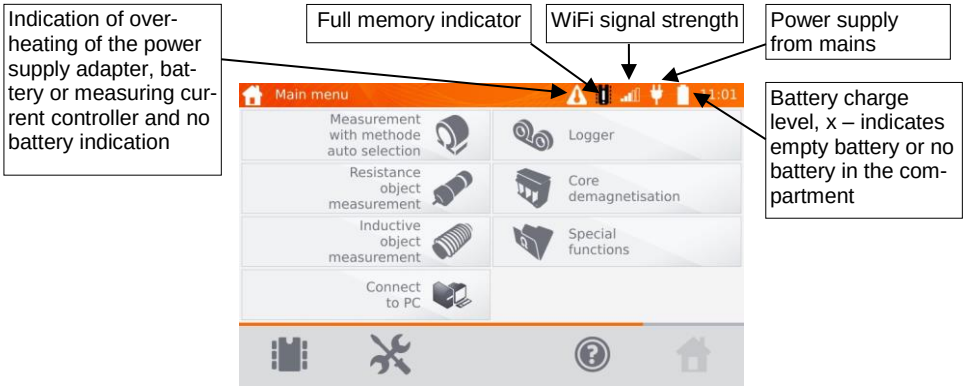
MMR-650 is a meter designed for measuring resistance of various types of connections (welded, soldered, butt) in electrical installations as well as in inductive devices (transformers, motors) and it is used to obtain results that determine safety condition of electrical installations. Therefore, in order to provide conditions for correct operation and accuracy of obtained results, the following recommendations must be observed:

- Before you proceed to operate the meter, acquaint yourself thoroughly with the present manual and observe the safety regulations and specifications provided by the producer.
- MMR-650 meter is designed to measure low-resistance values. Any application that differs from those specified in the present manual may result in a damage to the device and constitute a source of danger for the user.
- In case of measurements on systems, components and devices that may be under dangerous voltage, MMR-650 may be used only by qualified persons who are authorized to work on electric installations. Unauthorized use of the meter may result in its damage and may be a source of serious hazard to the user.
- Using this manual does not exclude the need to comply with occupational health and safety regulations and with other relevant fire regulations required during the performance of a particular type of work. Before starting the work with the device in special environments, e.g. potentially fire-risk/explosive environment, it is necessary to consult it with the person responsible for health and safety.
- It is unacceptable to operate the device when:
  ⇒ a damaged meter which is completely or partially out of order,
  ⇒ a meter with damaged insulation,
  ⇒ a meter stored for an excessive period of time in disadvantageous conditions (e.g. excessive humidity). **If the meter has been transferred from a cool to a warm environment with a high level of relative humidity, do not start measurements until the meter is warmed up to the ambient temperature (approximately 30 minutes).**
- Before measurement make sure that test leads are connected to appropriate measuring terminals.
- Do not operate a meter with an open or incorrectly closed battery compartment and do not power it from other sources than those specified in this manual.
- The inputs of the meter are protected electronically against overload e.g. due to having been connected to a live circuit:
  - for all combinations of inputs - up to 600 V for 10 seconds.
- Repairs may be performed only by an authorised service point.
- The device meets the requirements of EN 61010-1, EN 61010-2-030 and EN 61010-031.

- The manufacturer reserves the right to introduce changes in appearance, equipment and technical data of the meter.
- An attempt to install drivers in 64-bit Windows 8 and Windows 10, may result in displaying "Installation failed" message.
  Cause: Windows 8 and Windows 10 by default block drivers without a digital signature.
  Solution**:** Disable the driver signature enforcement in Windows.

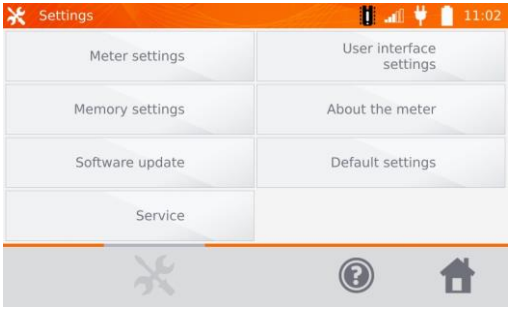
2 General settings – main menu

When the meter is turned on, it displays the main menu.



2.1 *Meter settings*

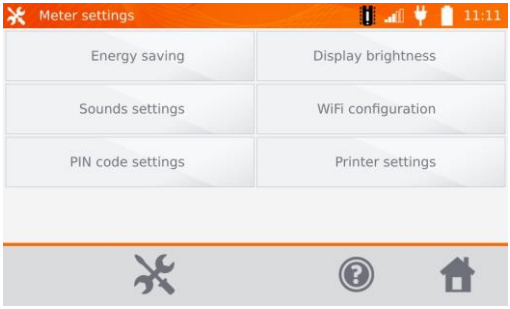
1. In the main menu, click icon .

2. 

Click **Meter settings** button.

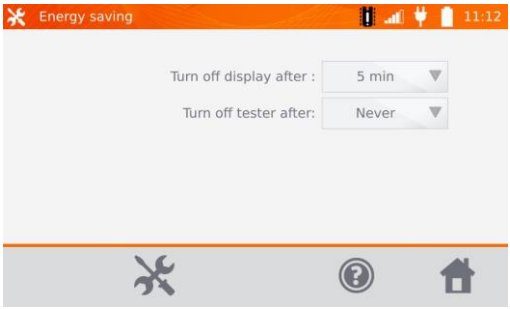
2.1.1 Energy saving

In order to save its rechargeable battery, the meter automatically shuts off or blanks the screen after an adjustable inactivity period.

1. 

Click **Energy saving** button

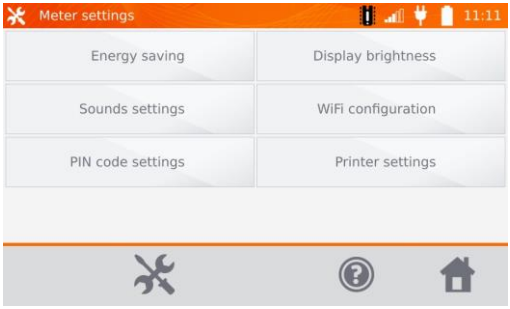
2



Set the inactivity time for blanking the screen and turning off the meter.

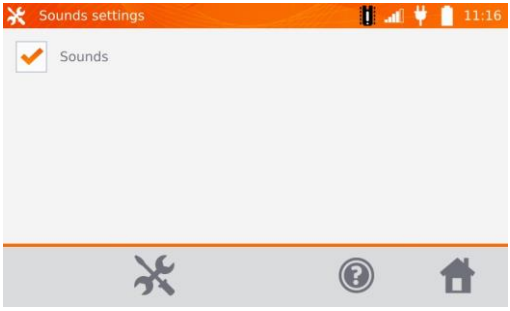
2.1.2 Sound settings

1



Click **Sound settings** button.

2

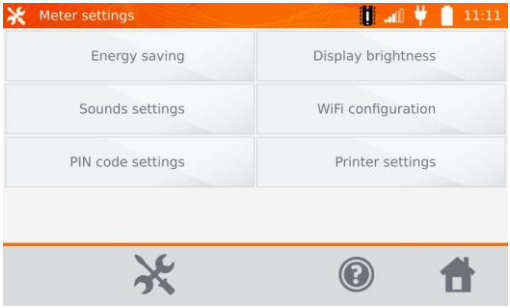


Click the box to turn on (✓) or off the sound signals.

2.1.3 PIN code settings

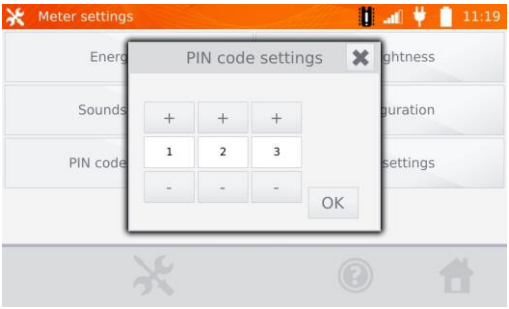
The PIN code is used for network connection with the meter.

1



Click **PIN code settings** button

2

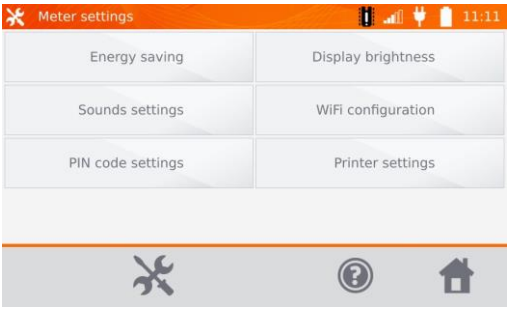


Use "**+**" and "**-**" buttons to set the code and confirm it by pressing **OK**.

The PIN code is used for communication with PC. The factory code is **123**.

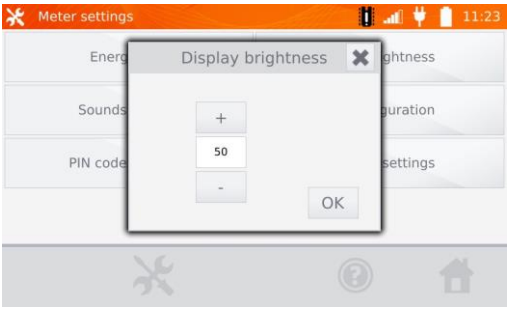
2.1.4 Display brightness settings

1



Click **Display brightness** button.

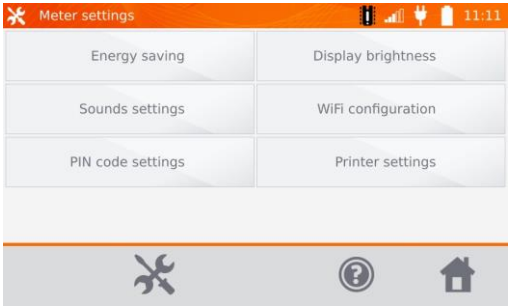
2



Use "**+**" and "**-**" buttons to set the desired brightness and confirm it by pressing **OK**.

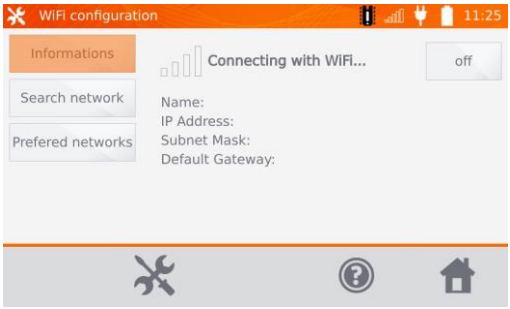
2.1.5 Wi-Fi configuration

1



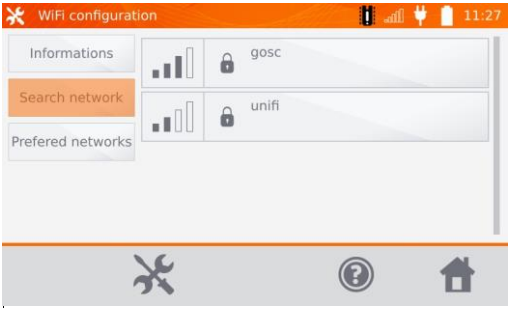
Click **WiFi configuration** button.

2



To see local active WiFi networks, click **Search network** button.

3

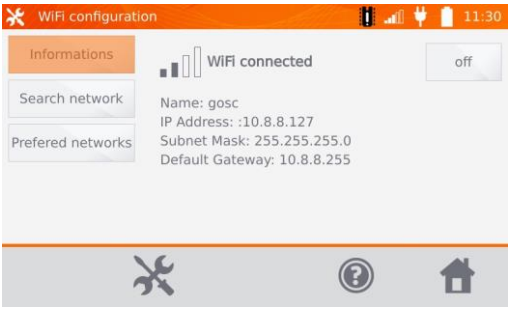


The meter detected networks secured by password. Click the name of the network to enter the password.

4

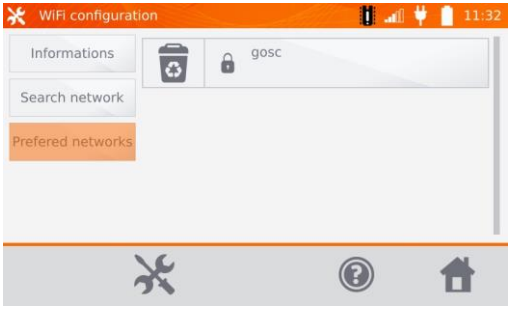
Enter the password and confirm it by pressing ↵. The meter connects to the network, which is automatically included in the list of trusted networks.

5



You may use **off** button to turn off WiFi.

6

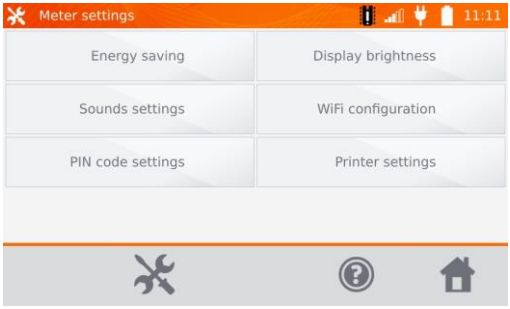


After clicking **Prefered networks** button, the meter will display networks saved in its memory.
You may delete the network by pressing button.

2.1.6 Printer settings

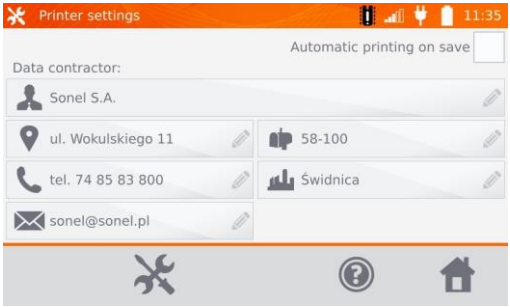
The meter is compatible with Sato CG2 printer.

1



Click **Printer settings** button.

2

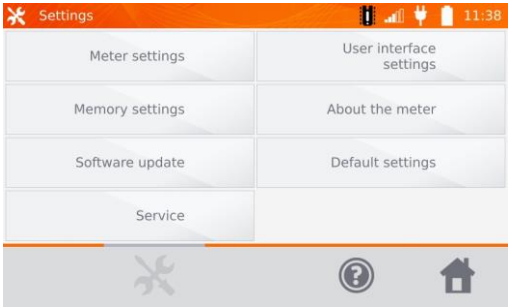


By clicking individual fields, you may change:
- the data of person/company performing the measurements, which will be printed,
- automatic printing on saving.

2.2 *Memory settings*

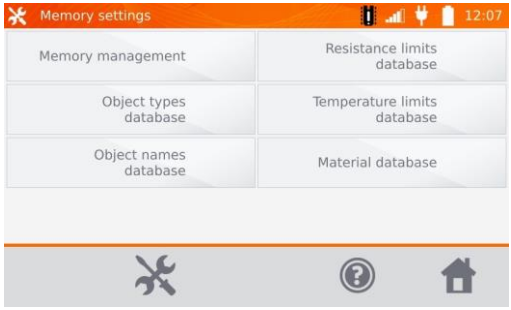
1. In the main menu, click button.

By pressing button, you may enter settings or enter the higher level in the settings.

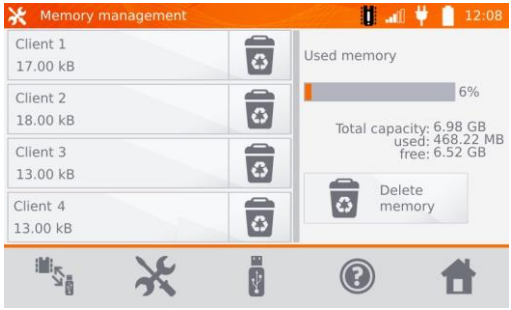
2. 

Click **Memory settings** button.

2.2.1 Memory management

1. 

Click **Memory management** button.

2. 

This option allows you to read the % of the used memory and to clear it: after pressing **Delete memory** all clients are deleted with their objects and measurement results. Use button located at the client to delete individual client.

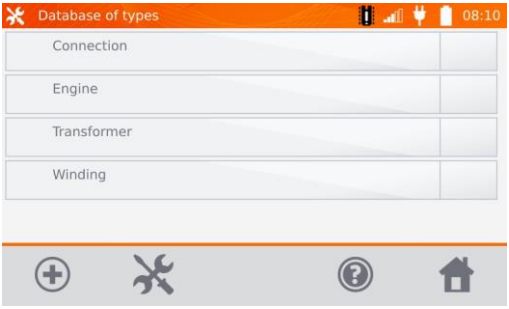
2.2.2 Object types database

This is a list of types of tested resistive and inductive objects.

1

Click **Object types database** button.

2

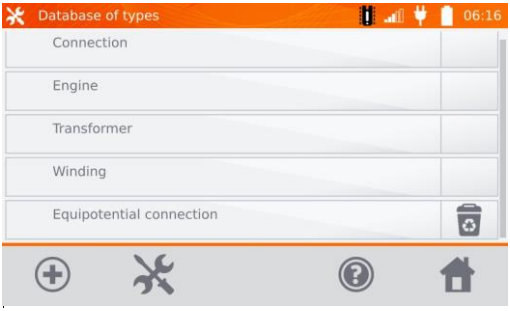


The meter has 4 default types saved in its memory. Use ⊕ button to add a new type of the tested object.

3

Enter a new type of the object being tested.

4

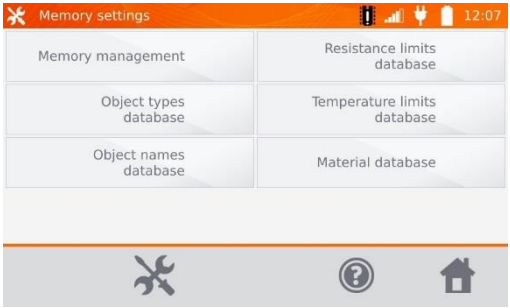


Added types may be deleted by pressing 🗑.

2.2.3 Object names database

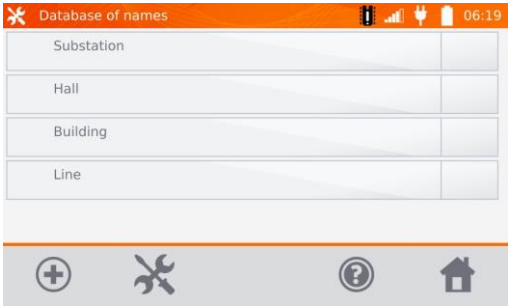
It is a list of names of tested objects or measurement points.

1



Click **Object names database** button.

2



The meter has 4 default names saved in its memory. Use ⊕ button to add a new name.

3

Enter the name of the object.

4

Added names may be deleted by pressing 🗑.

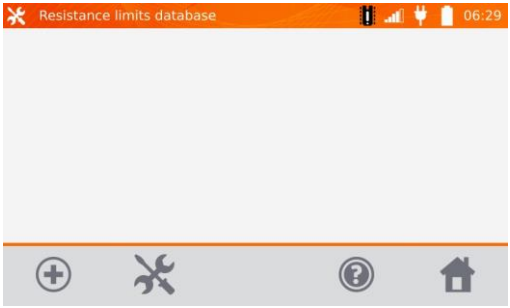
2.2.4 Resistance limits database

The specified limits may be used to automatically assess the validity of the results of resistance measurements.

1

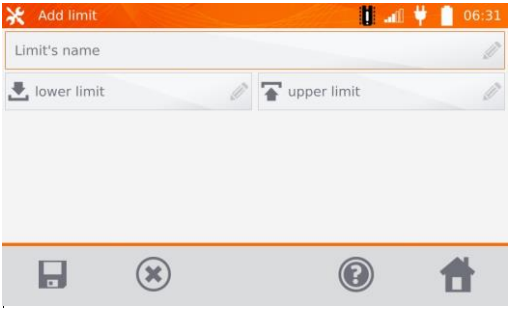
Click **Resistance limits database** button.

2



Click ⊕ button, to add a new limit.

3



Click **Limit's name** box.

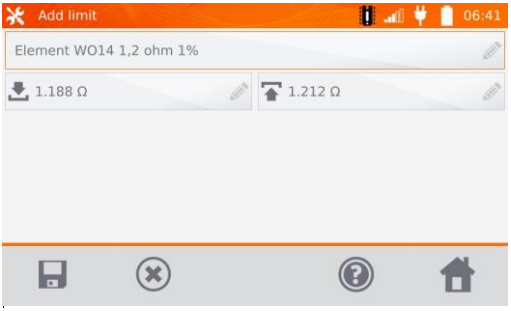
4

Enter the name of the limit. Use ▶ button to go to the lower limit setting.

5

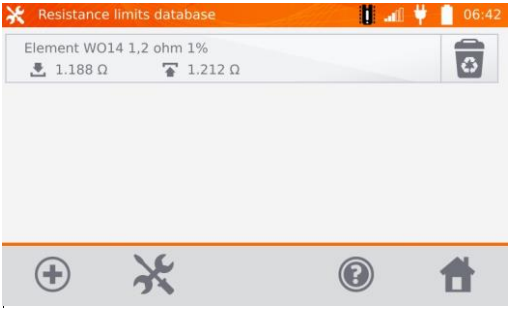
Enter the lower limit. Use ▶ button to go to the upper limit setting. You can set only one of the limits.

6



Use 💾 button to save the limit in the memory. By pressing ⊗ you may exit without saving.

7

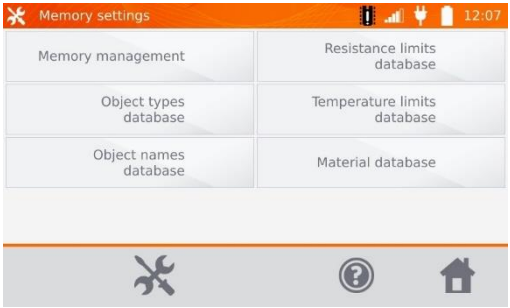


Use 🗑 button to cancel the limit.

2.2.5 Temperature limits database

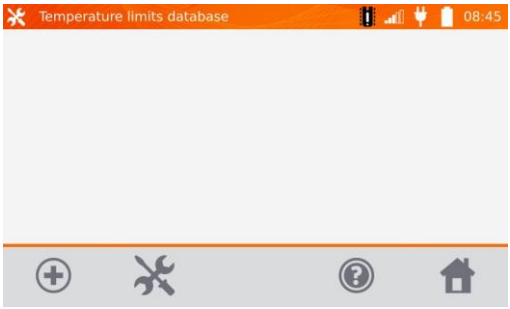
The specified limits may be used to automatically assess the validity of the results of temperature measurements.

1



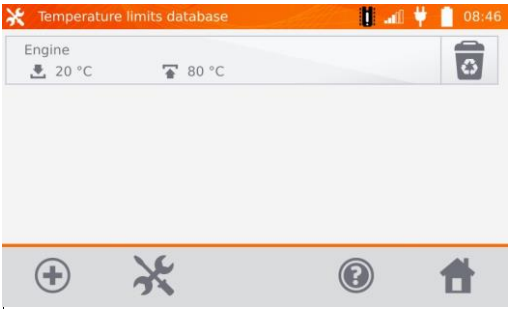
Click **Temperature limits database** button.

2



Click ⊕ button, to add a new limit.

3



Enter and save the limits using the same method as described in section 2.3.4.
Use 🗑 button to cancel the limit.

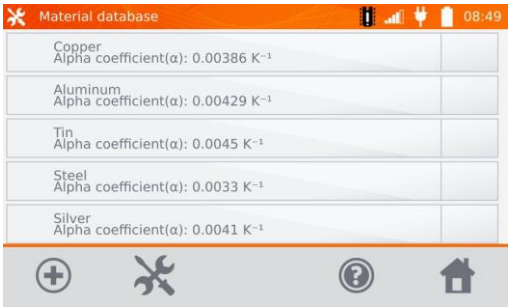
2.2.6 Material database

The database contains the temperature coefficients of resistance for different materials, used in measurements with temperature compensation.

1

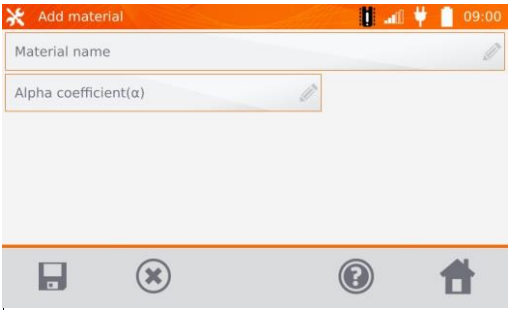
Click **Material database** button.

2



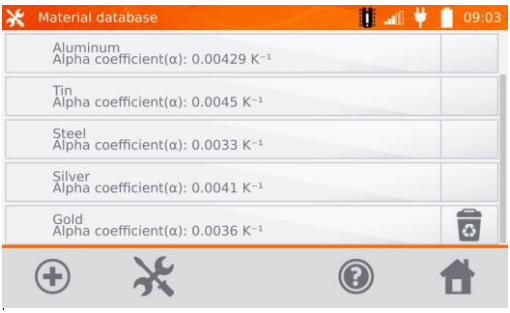
The meter has 5 defaults materials saved in the memory, together with the thermal resistance coefficients of: copper, aluminium, tin, steel and silver. Use ⊕ button to add a new material.

3



Enter and save the material and α coefficient, using the same method as described in section 2.3.4.

4

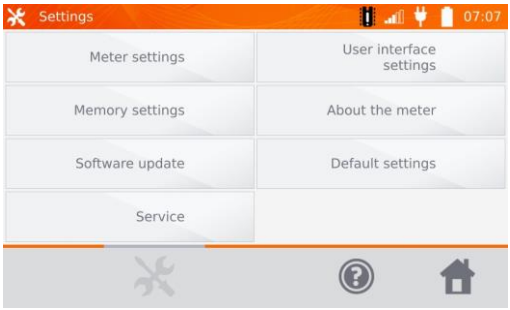


Use 🗑 button to delete the added material.

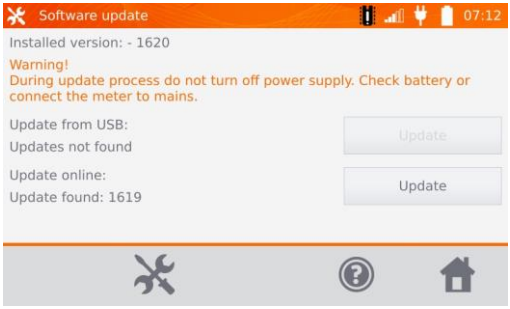
2.3 Software update

The software of the meter is periodically modified. You may download its current version from www.sonel.pl.

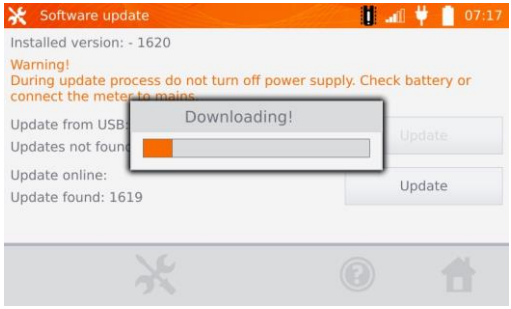
1. In the main menu, click icon .

2. 

   Click **Software update** button.

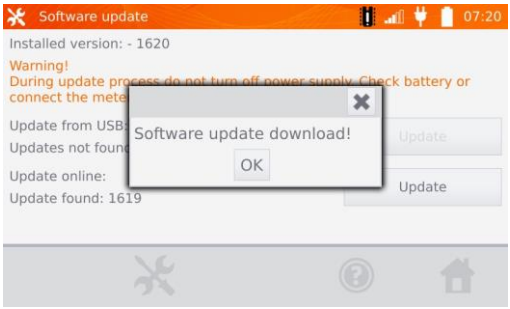
3. 

   Read the displayed text. To perform an update insert the USB drive with the update files and click **Update** or ensure Internet connection of the meter via WiFi, and click **Update** button.

4. 

   The meter is downloading software.

5



Click OK to run the update or close the window to cancel.

NOTE!

Update is performed automatically and may be divided into a few stages. During the update, do not turn off the power supply of the meter and do not remove the USB drive. The update process is continued until the meter displays the main MENU screen.

6

Only at this point, you can turn off the power supply of the meter or start its use.

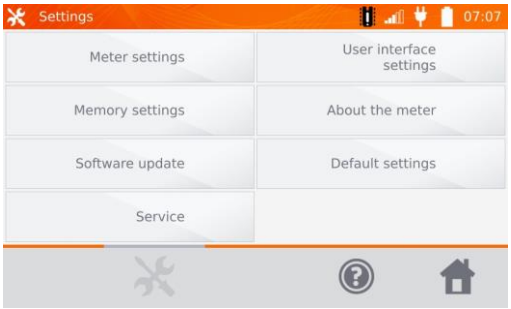
2.4 Service

This function is available for factory servicing and is protected by password.

2.5 User interface settings

1 In the main menu, click icon .

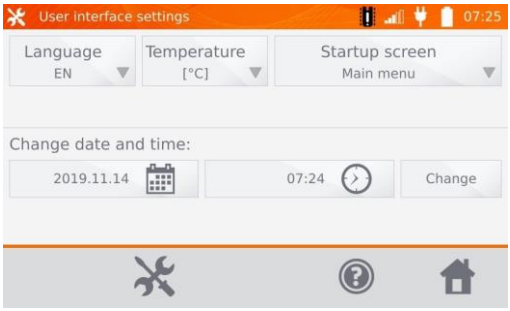
2



Click **User interface settings** button.

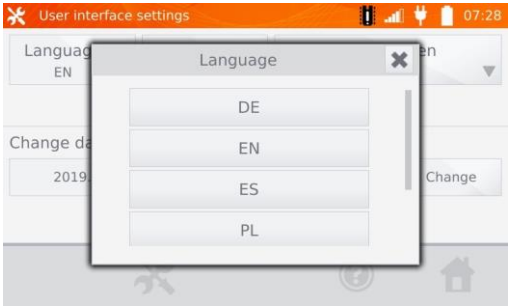
2.5.1 Language selection

1



Click **Language** button.

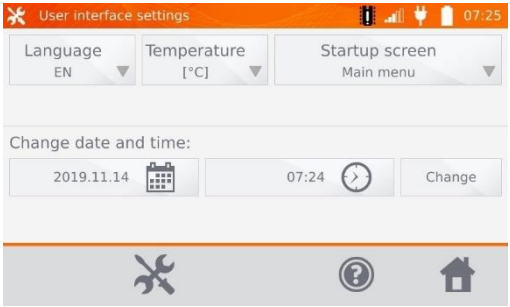
2



Click the selected language.

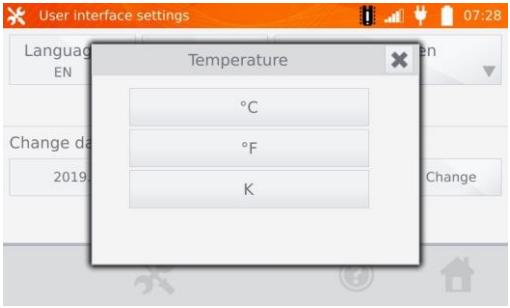
2.5.2 Selecting temperature unit

1



Click **Temperature** button.

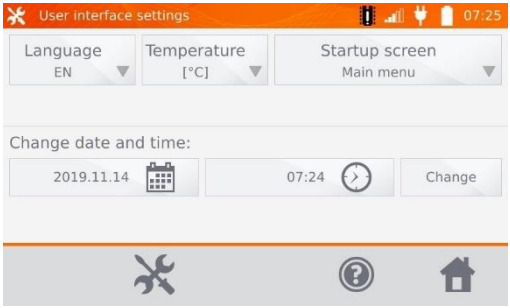
2



Click the button of selected unit.

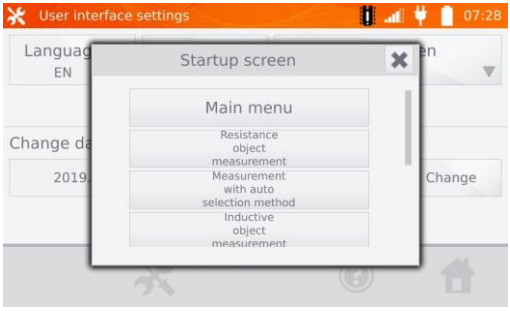
2.5.3 Selecting the startup screen

1



Click **Startup screen** button.

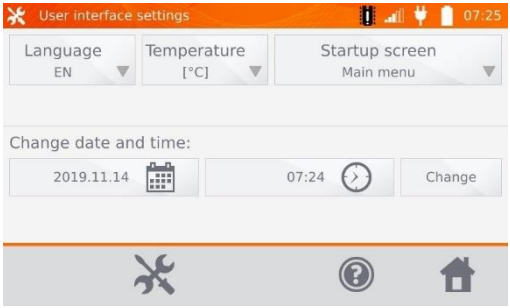
2



Click the selected startup screen (the screen will be automatically shown after turning on the meter). This feature is useful for making measurements of a given type for a longer period.

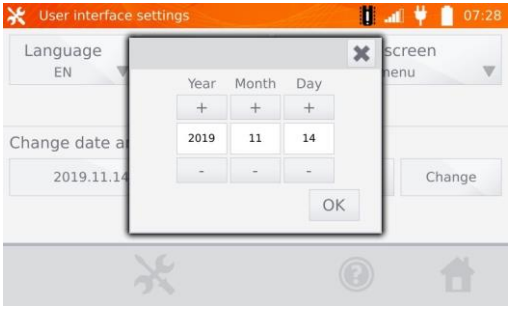
2.5.4 Changing the date and time

1



Click date button.

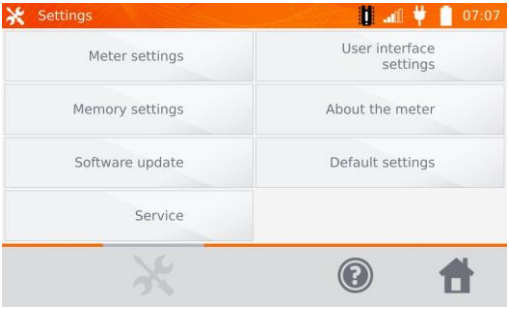
2



Use "**+**" and "**-**" buttons to set year, month and day, then and confirm it by pressing **OK**.
Similarly, you may set the time. To make changes, click **Change** button.

2.6 *Information about the meter*

1. In the main menu, click icon .

2. 

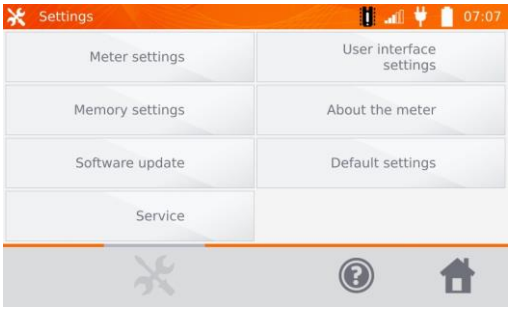
Click **About the meter** button.

3.

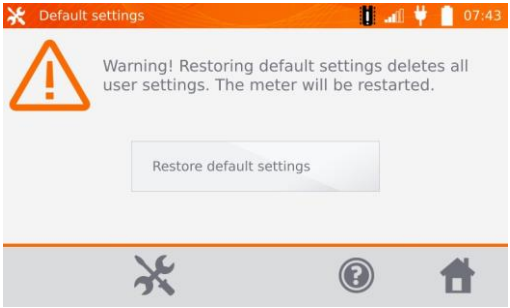
The screen will display information on the meter and its manufacturer.

2.7 Factory (default) settings

1. In the main menu, click icon .

2. 

Click **Default settings** button.

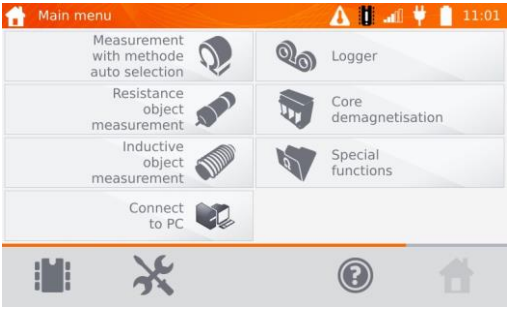
3. 

Read the note and click the button to restore the default settings, click button to cancel and return to the menu.

The following elements are restored to the default settings:

- measurement settings,
- list of object types,
- list of object names,
- list of materials,
- list of R limits,
- list of T limit,
- sound settings,
- default startup screen,
- the list of Wi-Fi networks,
- temperature unit,
- PIN code settings,
- energy saving settings,
- display brightness.

2.8 Communication with PC

1. 

Press **Connect to PC**.

2. On your PC run **Sonel Reader** or **Sonel Reports PLUS**.

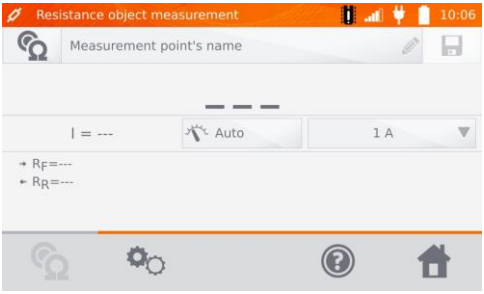
3. To terminate the connection press ⊗.

3 Measurements

- The measurement with temperature compensation is performed when the user wants to know the resistance of the object at a certain reference temperature, and the measurement is made at another temperature. Basing on the temperature coefficient of resistance 'α' of the measured object, the meter calculates the resistance value at the reference temperature.
- When using the function of temperature compensation, the declared measurement accuracy is valid for the result before the compensation.
- If the current test leads are not connected, a message appears: **Lack of continuity of current leads**.
- If the voltage test leads are not connected, a message appears: **Lack of continuity of voltage leads**.

3.1 Testing the resistance objects

1

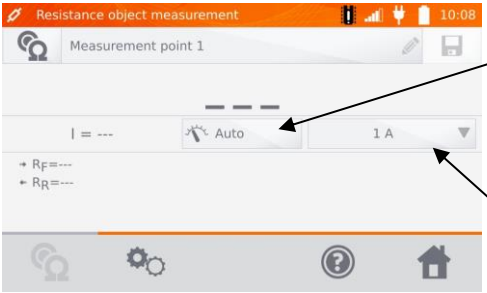


2

When necessary, name the measuring point.

- After entering the name of the measuring point, the measurement result will be saved in the memory and after selecting the client and object (subobject) you may simply click button to create and save the point automatically.
- When during the logging process you click a point already existing in the memory, then its name created during the memory management will be overwritten by the name typed in the measurement box.

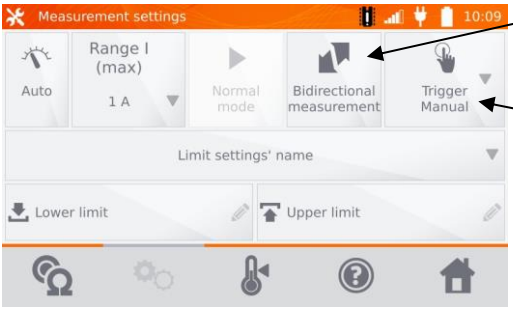
3



Auto/Manual switch (auto / manual range selection): Auto - the measuring current is limited to a value not exceeding the set value, Manual - measuring current has the set value.

Setting the measuring current.

④ Use button to go to the next settings.



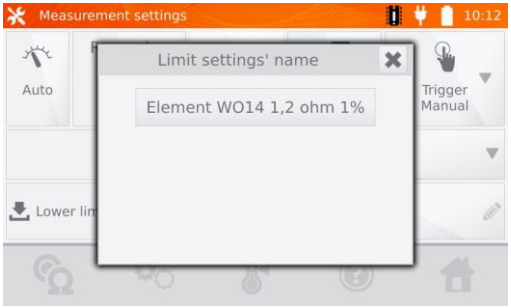
Switching Unidirectional/Bidirectional measurement.

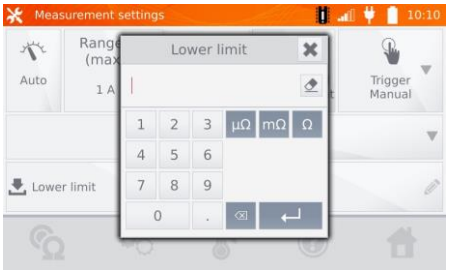
Selecting trigger method:
- manual: use **START/STOP** button
- automatic: by connecting test leads to the object
- continuous: the measurement is triggered and ended by pressing **START/STOP** button.

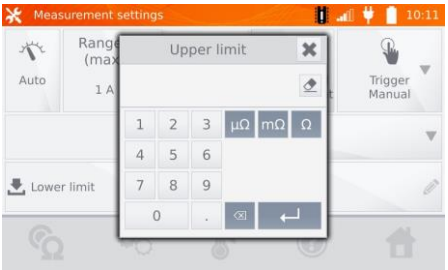
Boxes for setting the range and measurement current on the screen above correspond to the same boxes shown in the previous screen.

- Bidirectional measurement is used to compensate the potential present at the contact point of two different conductors. In this case, the main result of the measurement is the average of results from individual directions.
- After selecting automatic trigger, the first measurement must be started by pressing **START/STOP** button, next measurements may be initiated by connecting the test leads to the object.
- Automatic trigger operates correctly for resistance ≤ 4 kΩ, above this value there is no guarantee of correct operation.

⑤ If necessary, select resistance limits from the database (click **Limit settings' name**) or set the required limits for the performed measurement by clicking **Lower limit** and/or **Upper limit**.





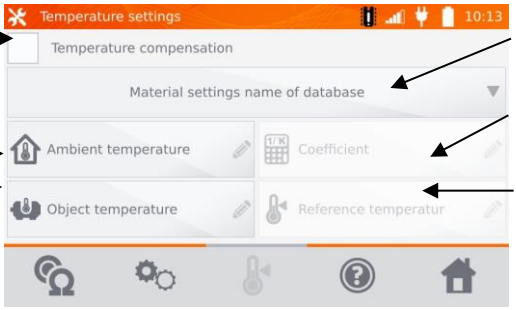


6 Click button to enter the temperature settings. After checking "Temperature compensation" box, the meter uses the specified temperatures and temperature coefficient of resistance to calculate the resistance at the reference temperature.

Turning on/ off the temperature compensation.

Enter the ambient temperature – optional.

Enter the temperature of the object measure it with a thermometer connected to the meter socket.



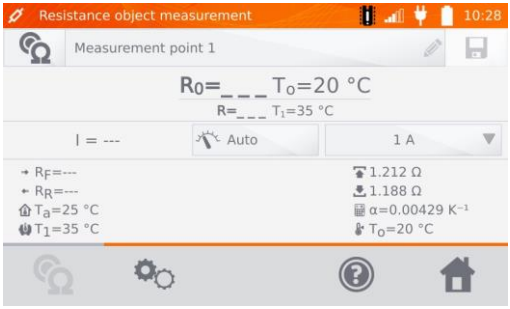
Select a material from the database or

enter α coefficient for the tested object.

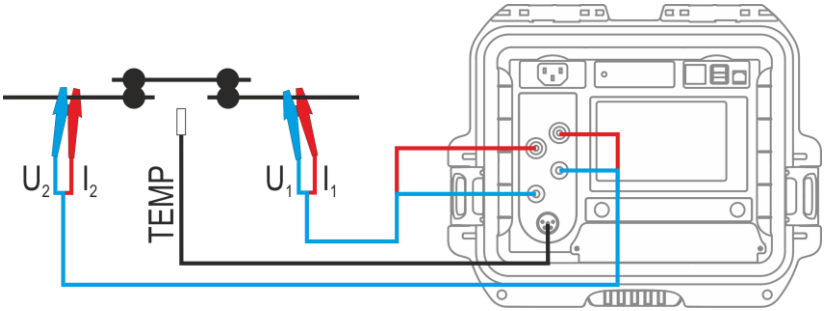
Enter the reference temperature, for which the result will be calculated.

- When you activate the temperature compensation, set all the values (not necessarily the ambient temperature) to exit to the measurement screen.
- The ambient temperature is added to the measurement report.

7 Press button to go to the measurement.



8 Connect the meter to the tested object. Press **START**/**STOP**.



Correct result: R_0 within limits.

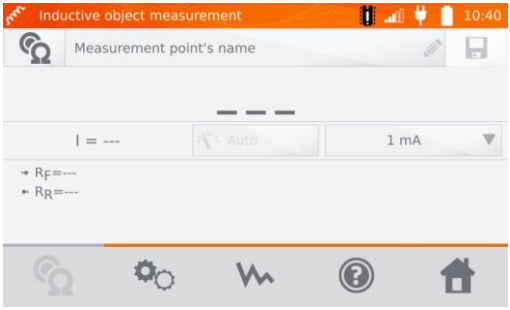
Incorrect result" R_0 outside limits.

R_0 – resistance at reference temperature
R_F – resistance at the measuring current flowing in the assumed positive direction
R_R – resistance at the measuring current flowing in the assumed negative direction
T_a – ambient temperature
T_1 – object temperature
T_0 – reference temperature
α - temperature coefficient of resistance
– upper limit
– lower limit

- The measuring current is obtained from the current source.
- Declared measurement uncertainty refers to the measured value; for value calculated with the reference temperature the uncertainty is not specified.
- The result may be entered into the memory by pressing button (see sec. 4.2).

3.2 Testing the inductive objects

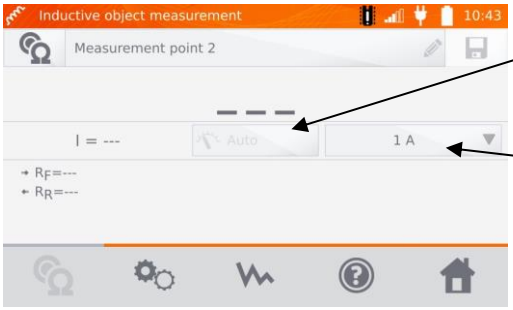
1



2

When necessary, name the measuring point.

3

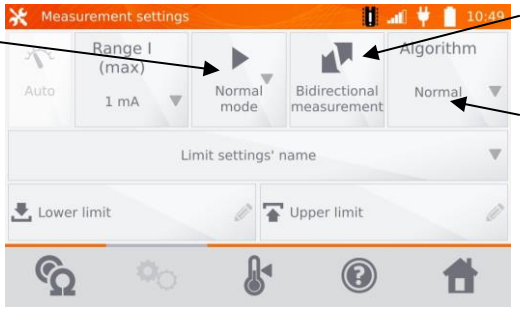


When measuring inductive objects, only Auto mode is available - the measuring current is limited to a value not exceeding the set value,

Setting the measuring current limits.

4 Use button to go to the next settings.

Selection of measurement mode:
- normal
- continuous: the measurement continues until it is turned off by pressing **START/STOP** button



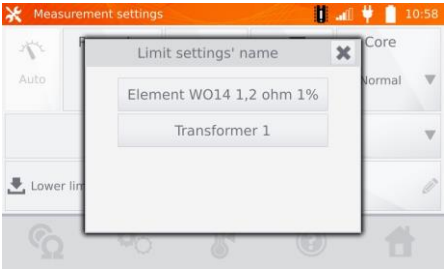
Switching Unidirectional/Bidirectional measurement.

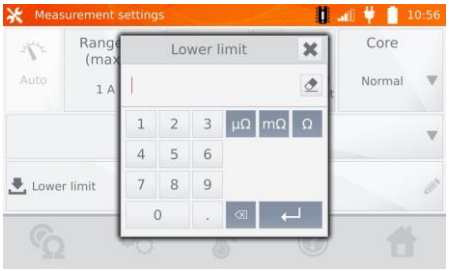
Algorithm selection:
- normal
- fast: greater tolerance for result stability criterion
- special – can be used among others for amorphous cores.

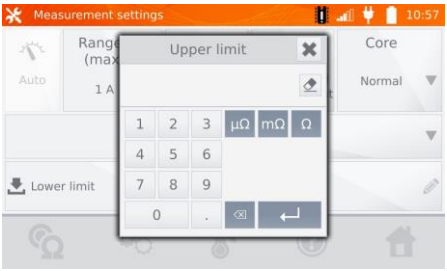
Boxes for setting the range and measurement current on the screen above correspond to the same boxes shown in the previous screen.

- Bidirectional measurement is used to compensate the potential present at the contact point of two different conductors. In this case, the main result of the measurement is the average of results from individual directions.
- Amorphous core is made of amorphous sheet, which has a non-crystalline structure that is closer to glass than metal. No-load losses in such a transformer are much lower than in traditional transformers. The process of measuring the resistance, due to the nature of the object, contains a measurement algorithm modified in relation to normal inductive objects.

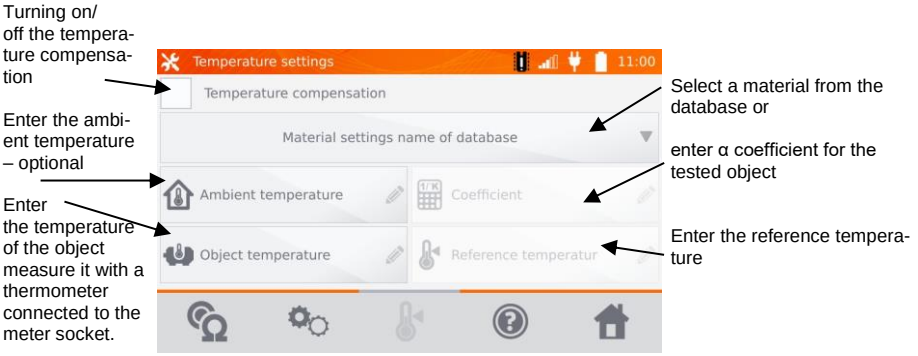
5 Select resistance limits from the database (click **Limit settings' name**) or set the required limits for the performed measurement by clicking **Lower limit** and/or **Upper limit**.





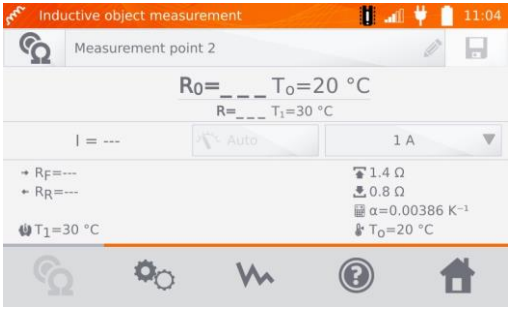


6 Click button to enter the temperature settings. After checking "Temperature compensation" box, the meter uses the specified temperatures and temperature coefficient of resistance to calculate the resistance at the reference temperature.

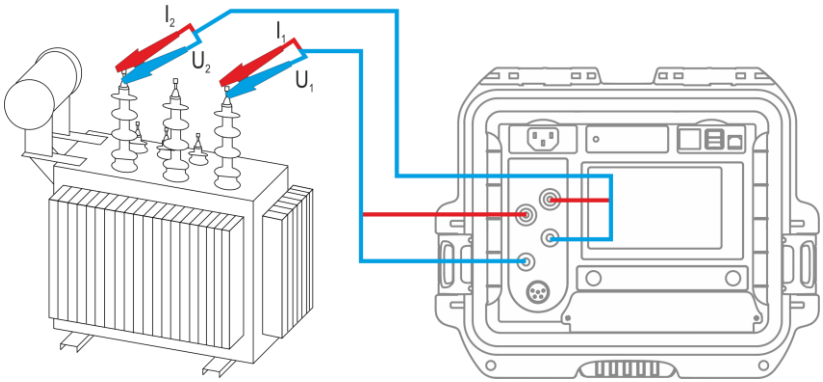


- When you activate the temperature compensation, set all the values (not necessarily the ambient temperature) to exit to the measurement screen.
- The ambient temperature is added to the measurement report.

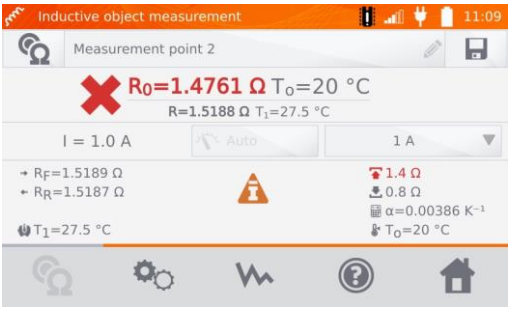
7 Press button to go to the measurement.



8 Connect the meter to the tested object. Press **START**/**STOP**.



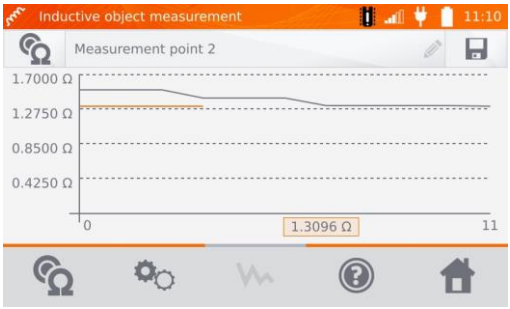
Correct result: R_{PE} within limits.



Incorrect result" R_{PE} outside limits.

R_F – resistance at the measuring current flowing in the assumed positive direction
R_R – resistance at the measuring current flowing in the assumed negative direction
T_a – ambient temperature
T_1 – object temperature
T_0 – reference temperature
α - temperature coefficient of resistance
– upper limit
– lower limit

9

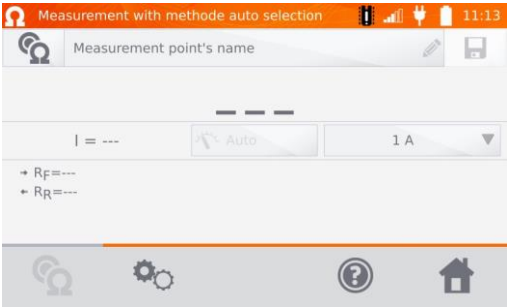


Use button to display the graph of resistance over time.

- It is recommended to use the maximum source power (set the current limit high enough), because then the core is saturated faster and the result stabilizes faster.
- Declared measurement uncertainty refers to the measured value; for value calculated with the reference temperature the uncertainty is not specified.
- Resistance values> 2 kΩ, displayed on the screen during the measurement are shown for information purposes - they have no specified accuracy.
- The result may be entered into the memory by pressing button (see sec. 4.2).

3.3 Measurement with automatic method selection

1



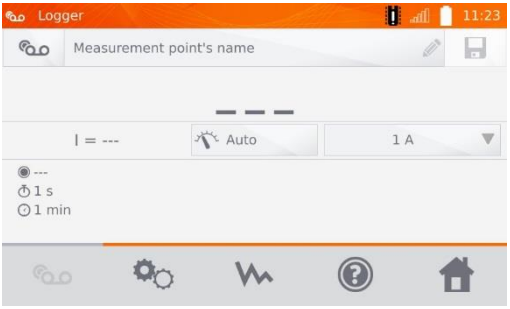
The measurement is performed as in the case of testing the inductive objects If based on the difference between the instantaneous and average resistance during the result stabilization, the meter determines that the object is resistive, it will complete the measurement faster.

For high power transformers it is recommended to use the measurement in the same mode as for inductive objects.

3.4 Logger

The logger is designed for logging the results with the interval from 1 second to 15 minutes.

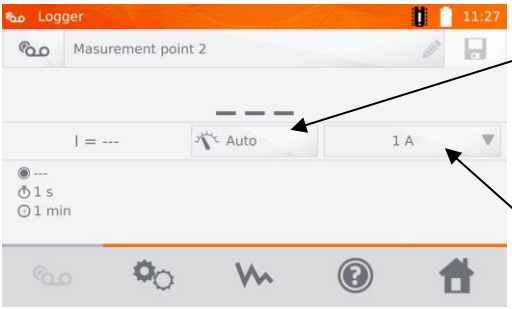
1



2

When necessary, name the measuring point.

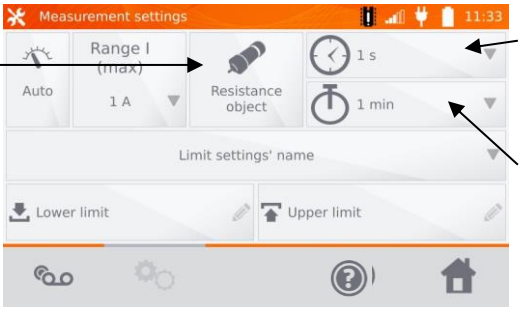
3



Switching between Auto/Manual mode:
Auto - the measuring current is limited to a value not exceeding the set value,
Manual - measuring current has the set value.
When measuring inductive objects, only Auto mode is available.

Setting the measuring current values or limits.

4 Use button to go to the next settings.



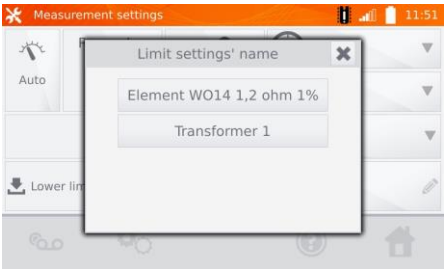
Selecting the object type:
- resistance
- inductive

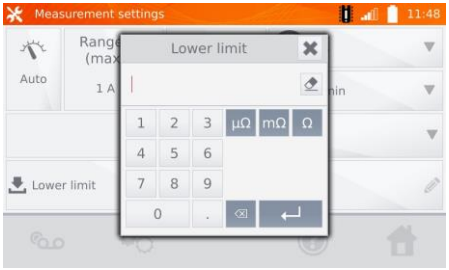
Selecting the time interval: 1 s, 5 s, 10 s, 15 s, 1 min, 5 min, 10 min, 15 min

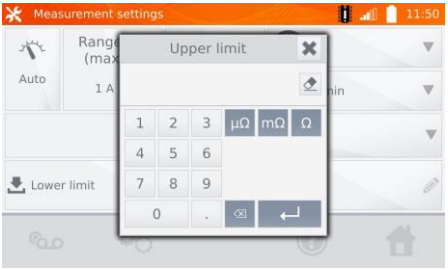
Selecting logging time: 1 min, 5 min, 10 min, 15 min, 30 min

The selected sampling time must be lower than the time set for logging, otherwise the meter will set the default times.

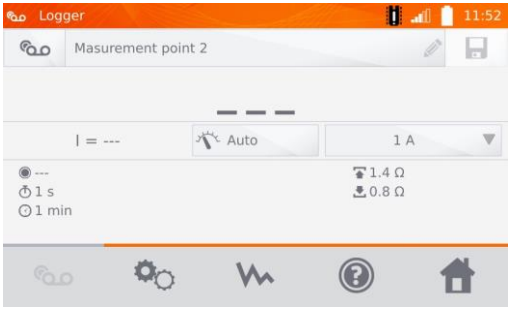
5 Select resistance limits from the database (click **Limit settings' name**) or set the required limits for the performed measurement by clicking **Lower limit** and/or **Upper limit**.





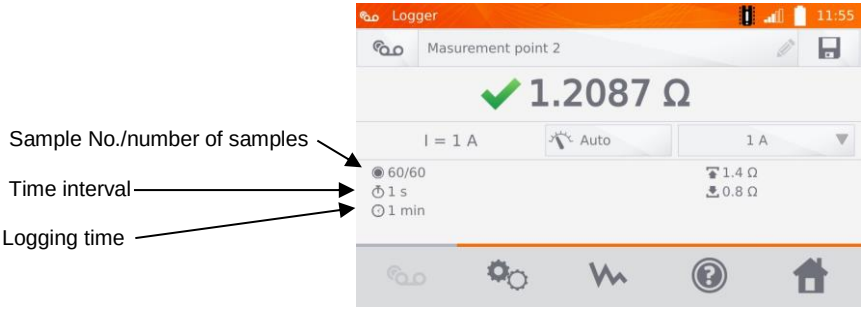


6 Press button, to enter the logger.



7 Connect the meter to the tested object. Press **START**/**STOP**.

8



Use button to display the graph of resistance over time - both during the logging process and after its completion.

After the logging process, the result may be entered into the memory by pressing button (see sec. 4.2). The values of individual samples may be read by viewing memory (see sec. 4.3).

3.5 Core demagnetization

After completing the winding resistance measurement, the magnetic core of the power transformer or measurement transformer may be magnetized. The demagnetization should be carried out to eliminate a source of potential problems. Demagnetization of the magnetic core requires the application of alternating current with decreasing the amplitude to zero.

1

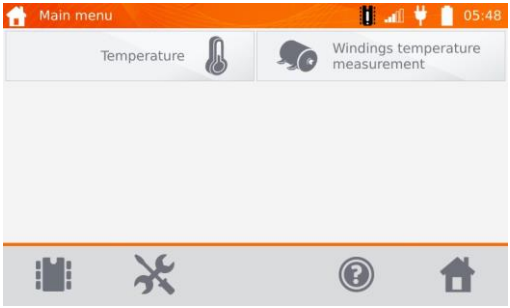
Core type selection:
- normal
- amorphous

2 Connect the meter to the transformer windings. Press **START**/**STOP**. Wait for the following screen.

3

It is recommended to carry out demagnetization from the low-voltage winding of the transformer.

3.6 Special features



The meter has two additional functions:

- temperature measurement,
- windings temperature measurement based on the resistance measurement.

3.6.1 Temperature measurement

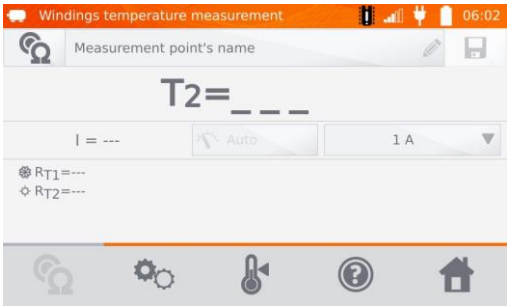
1. Connect the temperature probe to the appropriate socket in the meter.

2.

Read the temperature.

3.6.2 Windings temperature measurement

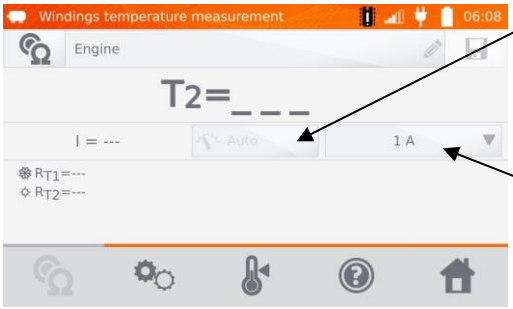
This function allows to calculate the temperature of windings for a heated object - e.g. motor, basing on the measured winding resistance at ambient temperature and after a period of operation, taking into account the temperature coefficient of resistance known for the winding material. It is assumed that after a significant stoppage time, the temperatures of the winding and motor block are the same. After a working period, initially the winding temperature differs from the temperature of the motor block. It may be calculated by measuring the change of the winding resistance.

1. 

2.

When necessary, name the measuring point.

3

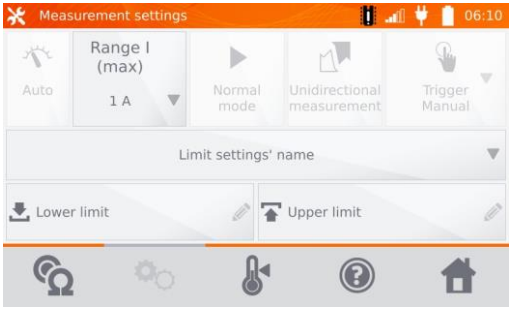


The method of supplying the measuring current is non-adjustable and set on Auto mode - the measuring current is limited to a value not exceeding the set value.

Setting the measuring current values or limits.

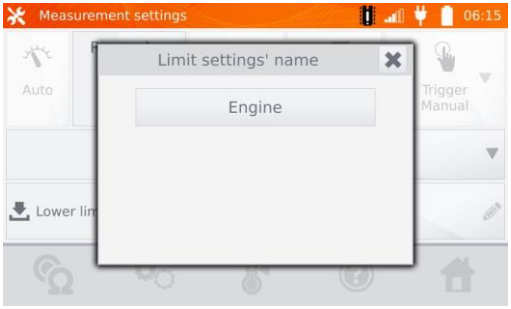
4

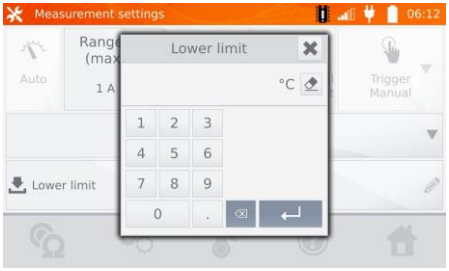
Use button to go to limit settings (mode, measurement and triggering are set as non-adjustable).

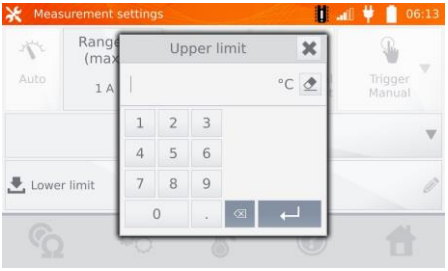


5

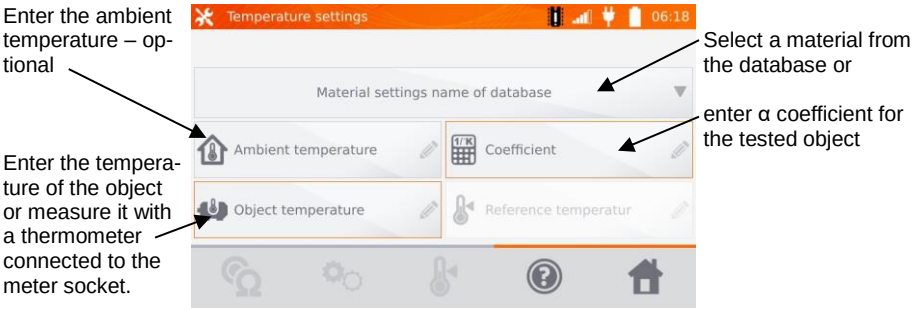
If necessary, select temperature limits from the database (click **Limit settings' name**) or set the required limits for the performed measurement by clicking **Lower limit** and/or **Upper limit**.





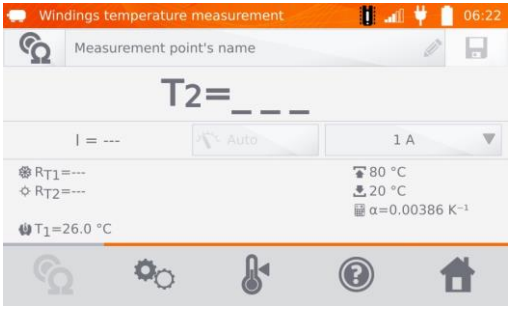


6 Click button to enter the temperature settings.

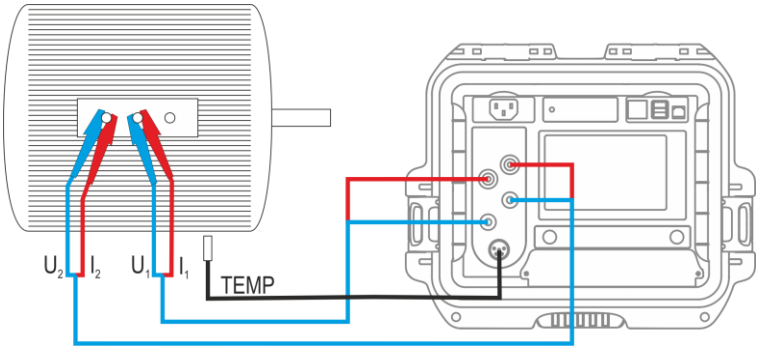


Entering factor "α" and the temperature of the object is necessary to exit to the measurement screen.

7 Press button to go to the measurement.

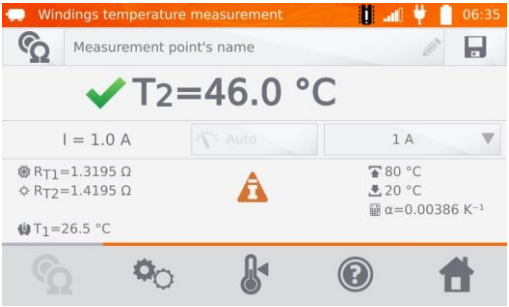


8 Connect the meter to the motor windings. Press **START**/**STOP**.



9 Disconnect the test leads from the motor, start the motor.

10 After the desired working time turn off the engine, reconnect the meter to the motor winding and press **START**/**STOP**.



R_{T1} – resistance of the cold winding
R_{T2} – resistance of the hot winding
T_1 – temperature of the cold object
α - temperature coefficient of resistance
– upper limit
– lower limit

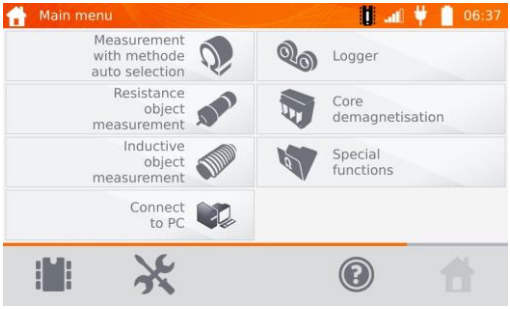
4 Memory

4.1 *Memory management (clients, objects, measuring points and logs)*

- The memory may be organized before the measurements, or on a regular basis, after the measurement.
- Use button to enter the memory management for measurements results or to enter a higher level in the memory.

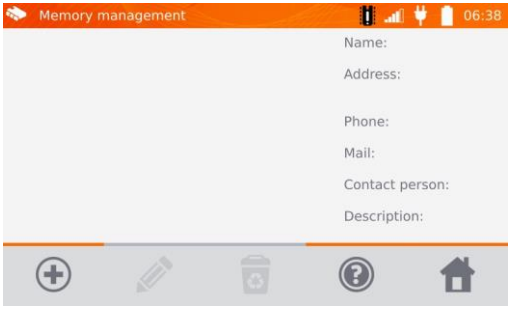
4.1.1 Entering the clients

1



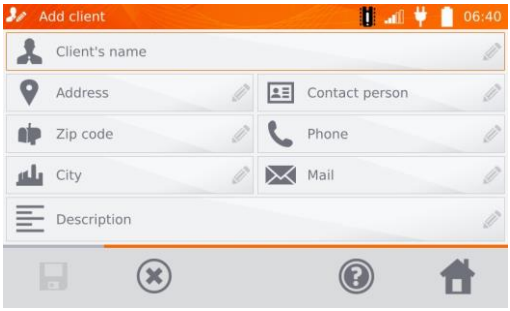
Click button, to enter the memory.

2



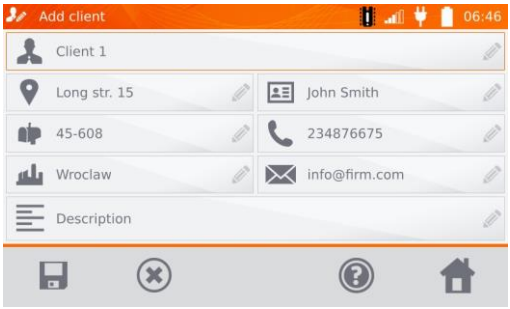
Click button to add a client.

3



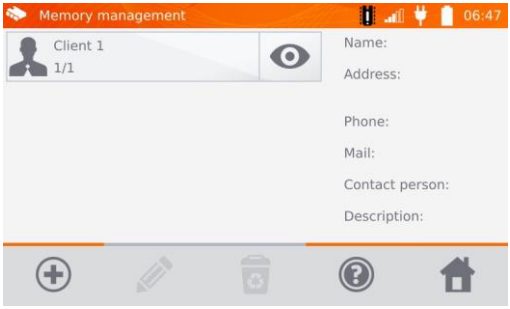
By clicking the individual fields, enter customer data using the keyboard. Client's name (box marked in orange) is mandatory.

4



Use button to save client's data in the memory.

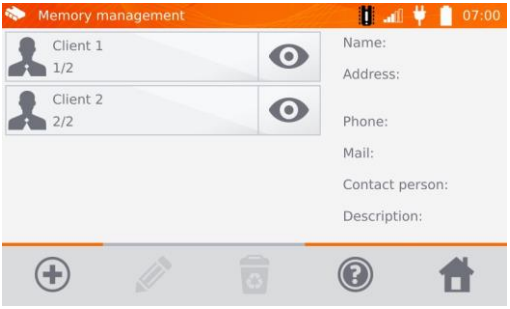
5



4.1.2 Entering objects, subobjects, measurement points and logs

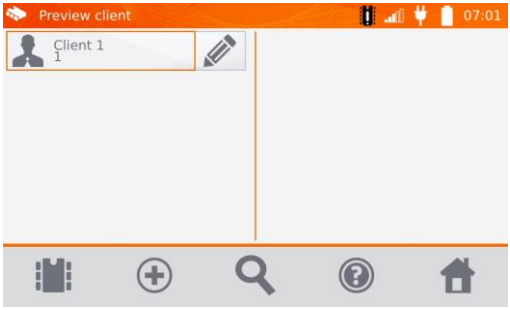
4.1.2.1 Entering objects and subobjects

1



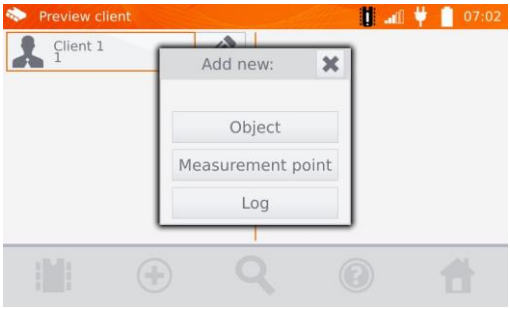
Click of the selected client.

2



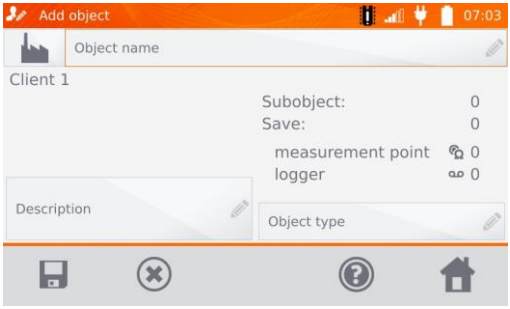
To add an object, measuring point or log, click button.

3



Click **Object** button.

4

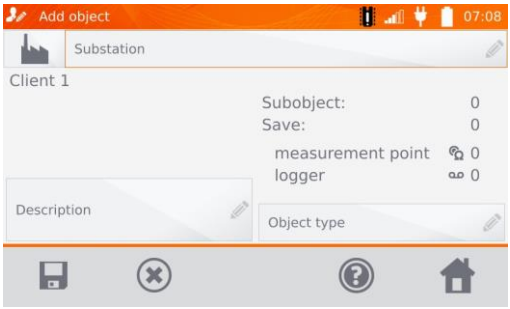


Click **Object name** box, to name the object - mandatory.

5

Select one of the default names or enter your own.

6

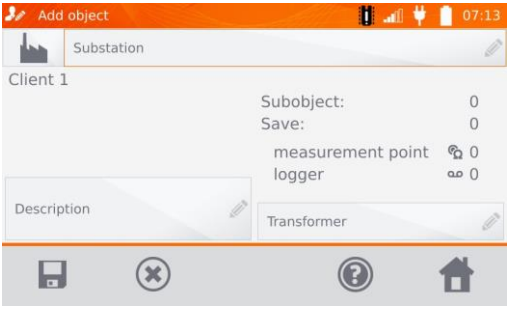


You may attach an additional description by clicking **Description** box. By clicking **Object type** box, you may select the default type of or enter your own.

7

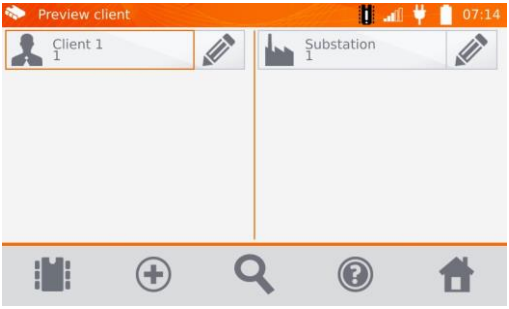
Select one of the default names or enter your own.

8



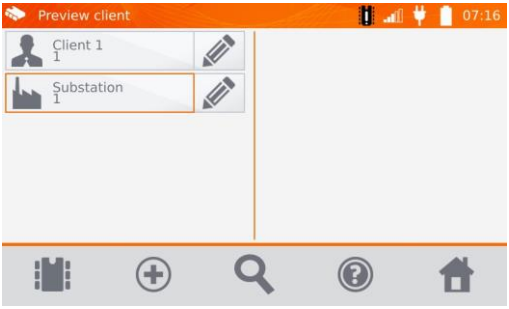
Use button, to save the object in the memory.

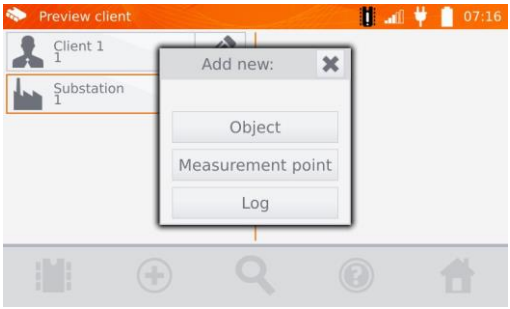
9



By clicking you can add more objects. By clicking the object field and button, you may enter subobjects in the object etc.- up to 4 levels.

10

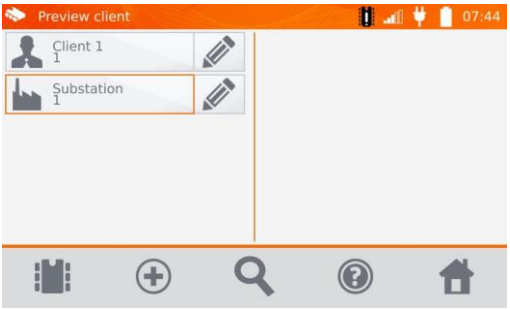




4.1.2.2 Entering measurement points and logs

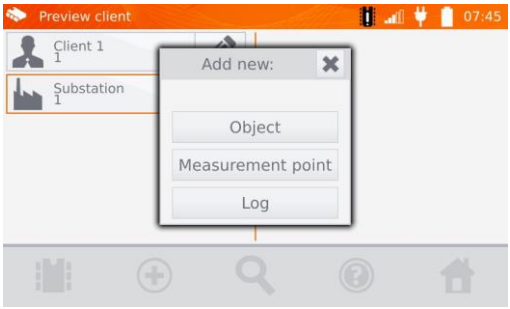
Measuring points and logs may be entered at any memory level, i.e. at the level of client object or subobject. Log is a measuring point distinguished due to performing a series of measurements in one point.

1



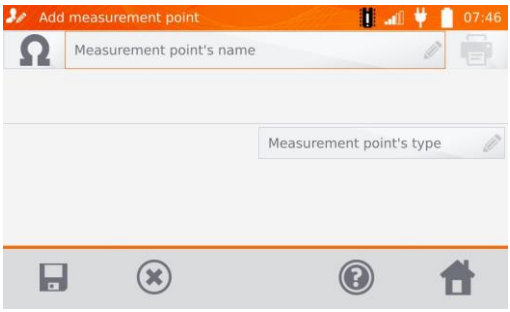
Click of the client, and then or press button at the level of the object (subobject).

2



Click **Measurement point** or **Log** button.

3

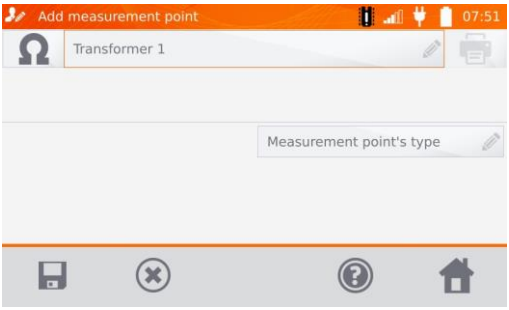


Click **Measurement point's name** box, to name the object - mandatory.

4

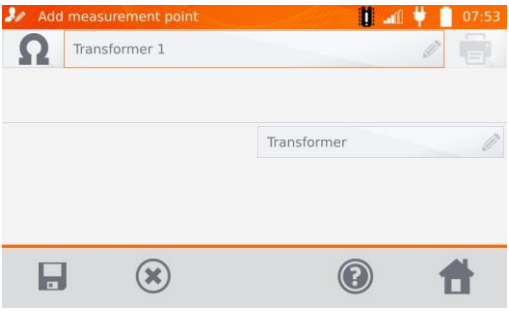
Select one of the default names or enter your own.

5



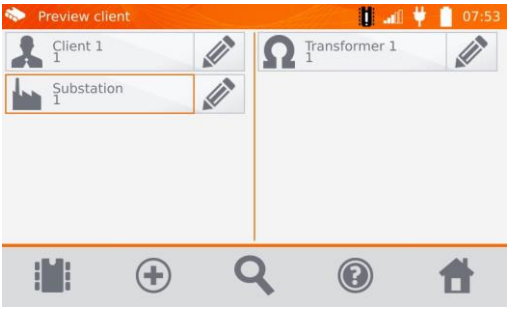
By clicking **Measurement point's type** box, you may select the default type of or enter your own.
For logging, it is possible to add an additional description, similarly as for the object.

6



Use button to enter a measuring point or log to the memory.

7



4.2 *Storing the measurement results in the memory*

NOTE!

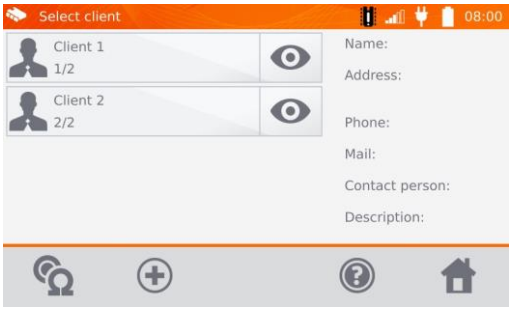
- Before performing the next series of measurements at the same measuring points, the previous results must be archived, because for one measuring point, you can save only one result and entering the next will erase the previous one.
- The measurement result may be entered only to the measuring point or to logger.

4.2.1 Entering the results of measurements with previously organized memory

1

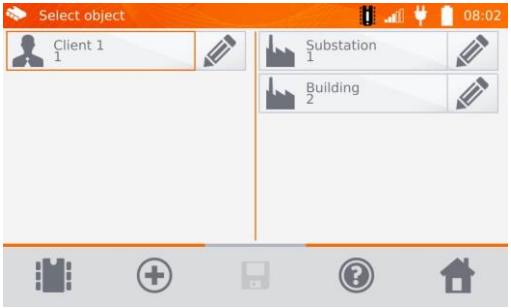
Press button after finishing the measurement.

2



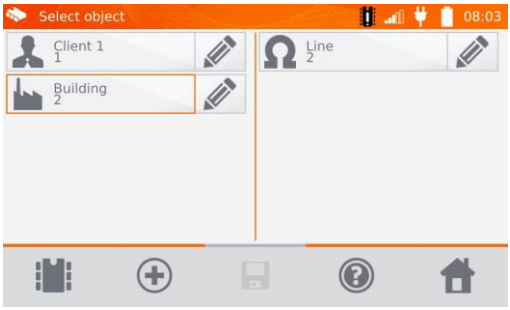
Select the client by clicking button next to its name.

3



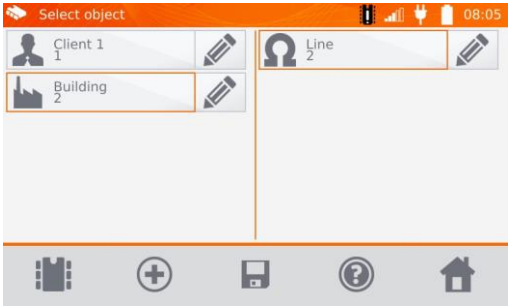
Select the object (subobject) by clicking its name.

4



Select the measuring point by clicking its name (indicated by orange border).

5



Save the result by clicking button.

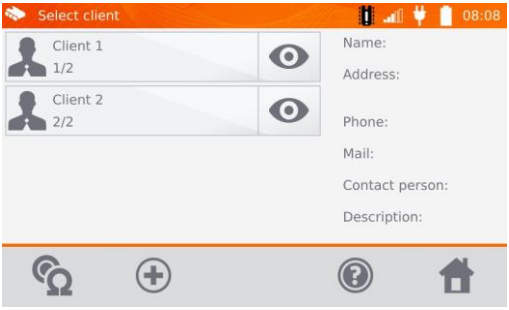
4.2.2 Entering the results of measurements without previously organized memory

Method 1

1

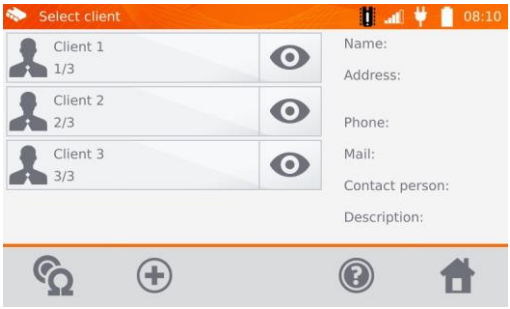
Press button after finishing the measurement.

2



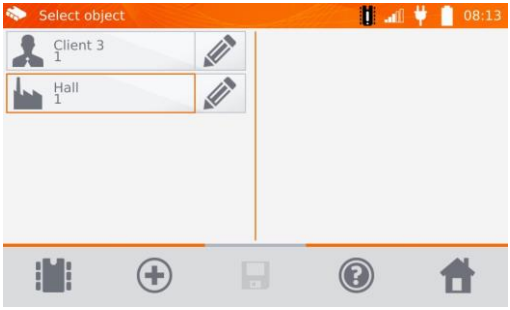
Click button to add a client.

3



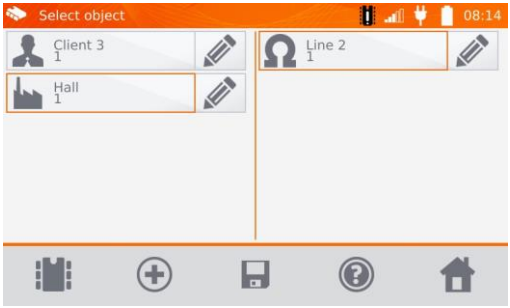
After saving the client click its button and then click button to add the object.

4

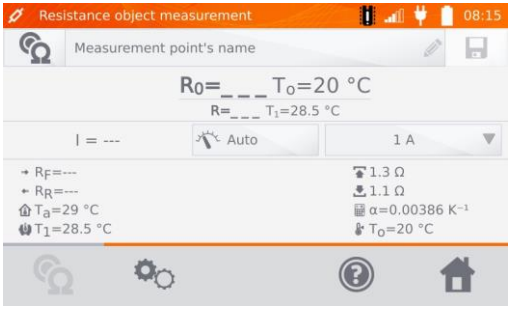


After adding and saving the object (also subobjects if necessary), click button to add the measurement point.

5



After adding and saving the measuring point, click . The result is saved to memory, the meter returns to the measuring mode.



Method 2

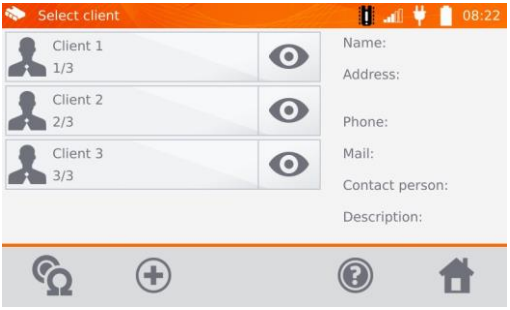
1

After the measurement or before click **Measurement point's name** and enter the name.

2

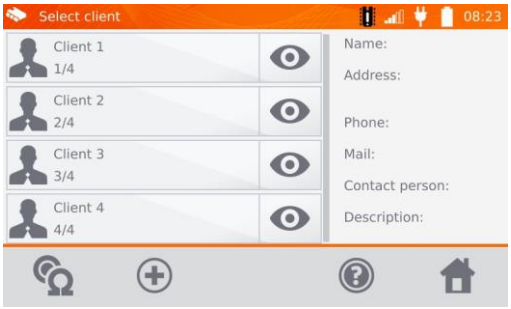
Press button after finishing the measurement.

3



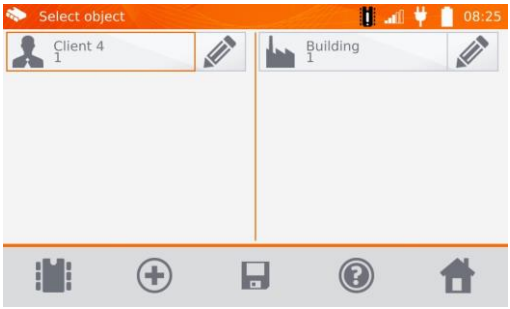
Click button to add a client.

4



After saving the client click its button and then click button to add the object.

5

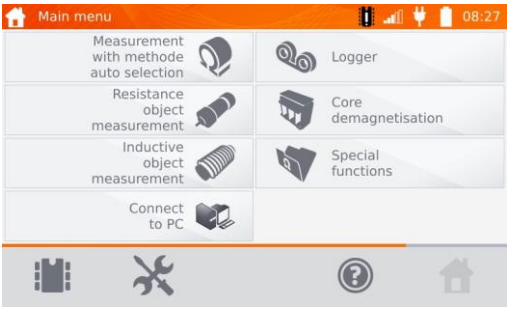


After adding and saving the object (also subobjects according to the needs), click the object and then button - the measuring point with the measurement result will be saved automatically.

Having selected the client and object (subobjects) and performing a series of measurements on one object, after the measurement and entering the name of the measuring point, click and the click again on the displayed screen - the measuring point with the measurement result will be saved automatically.

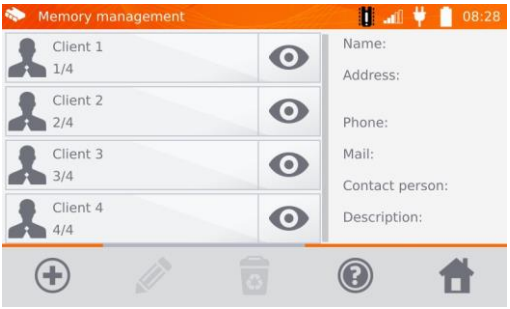
4.3 Viewing memory data

1



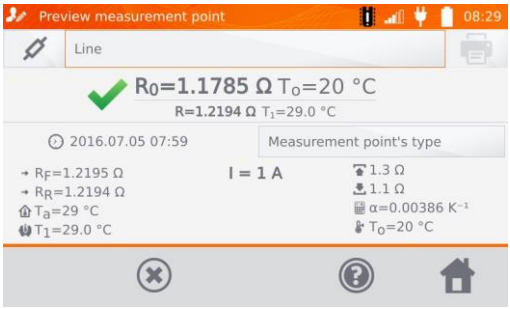
Click button, to enter the memory.

2

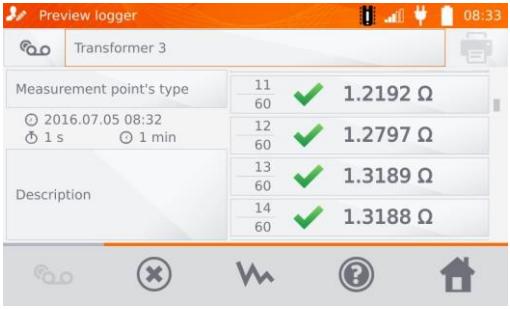


Click of the selected object and then click on the object, subobjects, measuring point or logger.

3

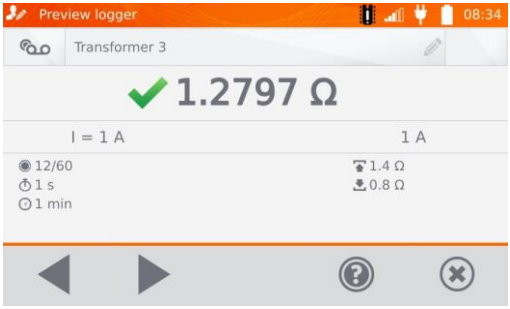


4



When using the logger, clicking the field with results will cause the meter to display the individual samples. You may scroll them using ◀, ▶ buttons. Use button to display the graph.

5



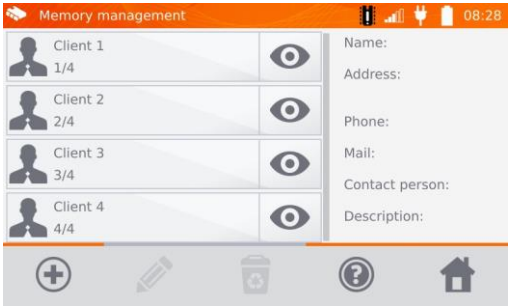
4.4 "Search" in the memory

In order to facilitate searching for an object or device in the memory, a function of memory search is added. To start the function of searching in the memory:

1

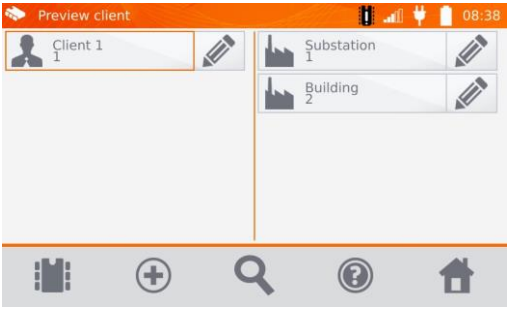
Click button.

2



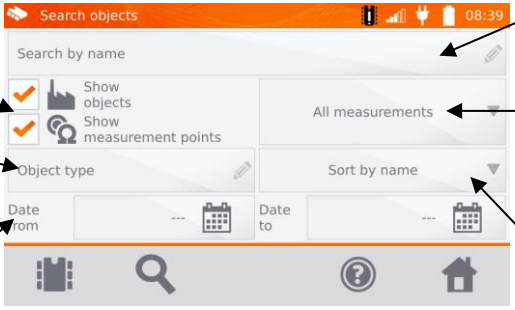
Click of the selected client.

3



In any of the client's window, click button.

4



Mark appropriate positions

Enter the object type or select the default type

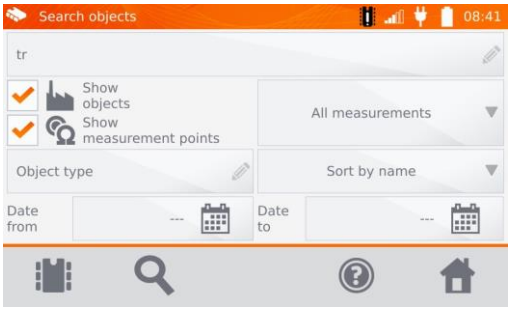
Enter the relevant dates

Enter the name or its several subsequent letters.

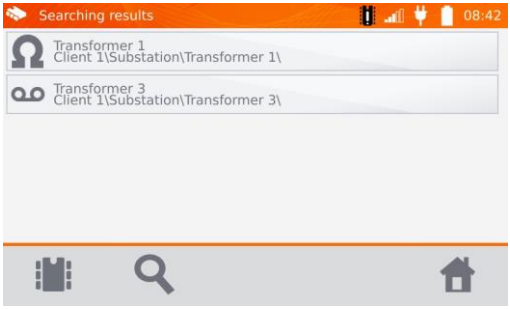
Select the type of the tested object:
- all
- resistive
- inductive

Selecting sorting by name or date

5



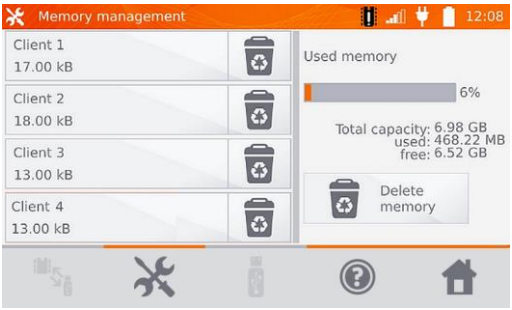
After entering all the search criteria, click button again.



- To perform the search, enter the name (or its part) or one of the dates.
- The size of letters in the name of searched item is ignored.

4.5 Copying customer data from the memory to USB stick and vice versa

1

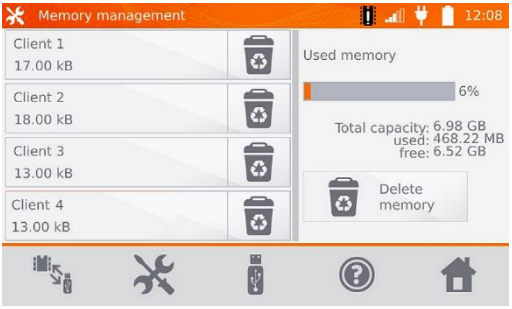


In the main menu, click , then **Memory settings** and **Memory management**.

2

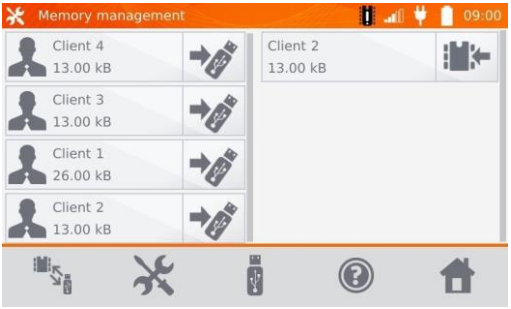
Insert the USB stick into the appropriate USB slot of the meter.

3



Click button.

4

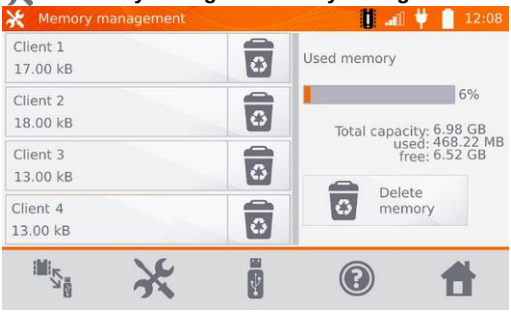


Click , to save data in the USB stick or to copy data from the USB stick to the memory of the meter.

4.6 Deleting data

4.6.1 Deleting the meter's memory data

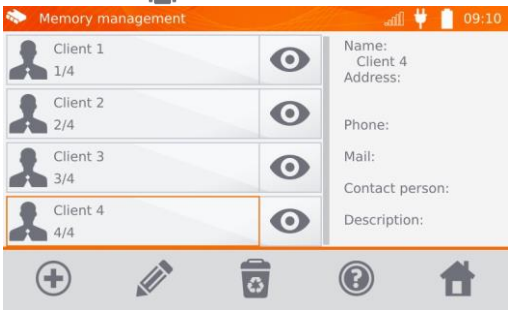
► **Memory settings** ► **Memory management**



To delete the whole memory, click **Delete memory** button.

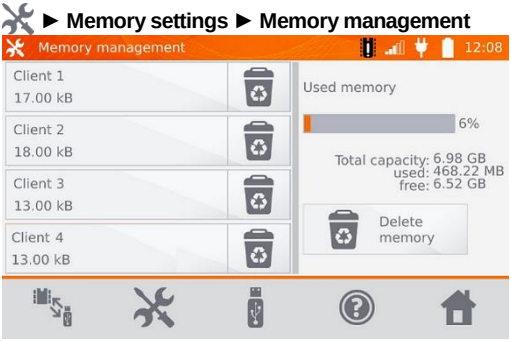
4.6.2 Deleting a client

1 **Main menu** ►



or

► **Memory settings** ► **Memory management**

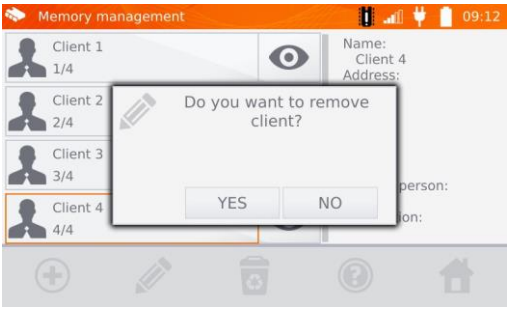


To delete a client:

⇒ in **location 1** select a client and then icon at the bottom bar,

⇒ in **location 2** select icon associated with its name.

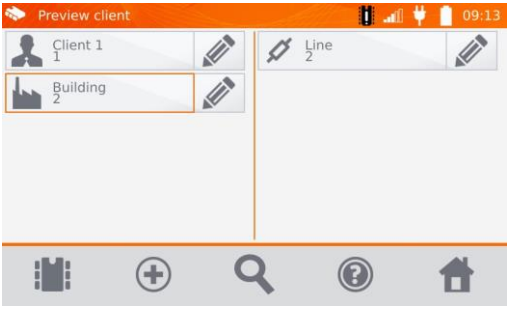
2



Click **YES** to confirm deleting or **NO** to cancel it.

4.6.3 Deleting an object

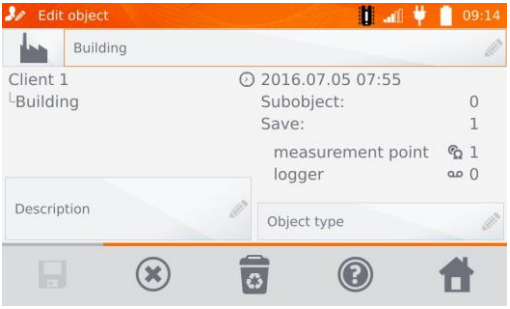
1



To delete an object or measuring point:

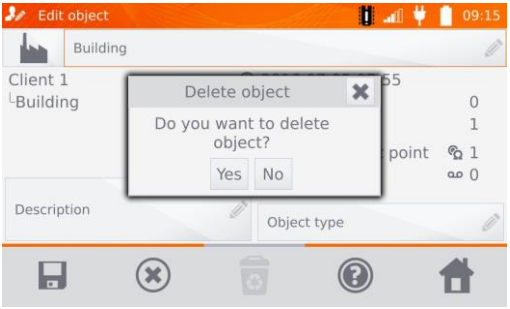
- go to location **Main menu** ► ,
- using icon go to the client's content,
- using icon start to edit the selected object…

2



…and then click button.

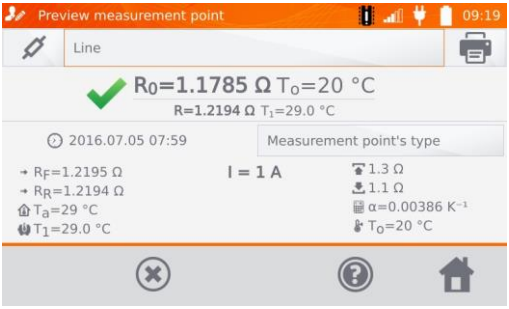
3



Click **YES** to confirm deleting or **NO** to cancel it.

5 Report printing

Sato CG2 printer must be connected to any of the USB socket of "Host" type. You can print measurement results directly after the measurement or stored in memory. Click icon to print it.



The printout includes all the results and parameters of the measurement, assessment (positive/negative), the date and time of measurement and data of person performing it, entered in the printer settings.

Log results are not printed.

6 Power supply

The meter is powered by an AC adapter or a battery pack. When supplied from the mains, the battery pack is charged.

6.1 Monitoring the power supply voltage

The charge level of the battery pack is indicated by the symbol in the right upper corner of the display on a current basis:

the battery pack is charged

the battery pack is discharged

the battery pack is being charged

NOTE!

Remember that measurements performed with an insufficient supply voltage feature additional errors which the user is unable to evaluate. Consequently, such measurements cannot prove that the results of resistance measurements are correct.

6.2 Replacing the battery pack

MMR-650 is equipped with a rechargeable lithium-ion battery pack and a charger for charging it. The battery pack is placed in the battery compartment. Battery charger is installed inside the housing of the meter and is compatible only with the manufacturer's rechargeable battery pack.

WARNING

If the power cord is left in the socket during replacement of the battery pack, there is a risk of electric shock with a dangerous voltage.

In order to replace the batter-pack it is necessary to:

- Remove all the test leads from the sockets and turn the meter off,
- remove the lid of the battery compartment (in the upper part of the housing) by removing 2 screws,
- remove the battery pack,
- remove two connector pins of the battery pack,
- connect the power plugs of the new battery pack,
- insert the battery pack into the battery compartment,
- place and tighten the lid of battery compartment.

NOTE!

Do not operate a meter with an open or incorrectly closed battery compartment and do not power it from other sources than those specified in this manual.

6.3 General rules for using Li-Ion rechargeable batteries

- If you do not use the device for a prolonged period of time, then it is recommended to remove the rechargeable batteries and store them separately.

- 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. Too low temperature should prevent starting the process of charging, which might irreparably damage rechargeable 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 its 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 casing of the meter may be cleaned with a soft, damp cloth using all-purpose detergents. Do not use any solvents or cleaning agents which may scratch the casing (powders, pastes, etc.).

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.
- make sure that the meter and accessories are dry,
- during prolonged storage remove the batteries,
- storage temperatures must be in accordance with those defined in technical specifications,
- in order to prevent total discharge of the rechargeable batteries during prolonged storage, charge them from time to time.

9 Dismantling and disposal

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, worn-out batteries and accumulators.

10 Technical data

10.1 Basic data

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

Uncertainty values stated in the table refer to the measurement with bidirectional current and relate to the average of two measurements according to the following formula:

$R = \frac{R_F + R_R}{2}$, where R_F – resistance at the assumed "forward" current direction and R_R – resistance at the assumed "backward" current direction. For measuring with unidirectional current, the specified accuracy is not guaranteed.

Resistance measurements of inductive and resistive objects

Range	Resolution	Accuracy *	Measuring current / voltage **
0 µΩ…999.9 µΩ	0.1 µΩ	Serial number up to CH0632: ±(0.25% m.v. + 2 digits) Serial number from CH0633: ±(0.2% m.v. + 2 digits)	10 A (20 mV)
1.0000 mΩ…1.9999 mΩ	0.0001 mΩ		
2.000 mΩ …19.999 mΩ	0.001 mΩ		10 A (200 mV)
20.00 mΩ..199.99 mΩ	0.01 mΩ		10 A / 1 A (2 V / 200 mV)
200.0 mΩ …999.9 mΩ	0.1 mΩ		1 A / 0.1 A (2 V / 200 mV)
1.0000 Ω…1.9999 Ω	0.0001 Ω		
2.000 Ω…19.999 Ω	0.001 Ω		0,1 A (2 V)
20.00 Ω…199.99 Ω	0.01 Ω		10 mA (2 V)
200.0 Ω…1999.9 Ω	0.1 Ω		1 mA (2 V)

* - for measurements on inductive objects in fast mode: ±(2% m.v. + 2 digits)
** - applies to measurements on resistance objects, for measurements on inductive objects output voltage ≤ 10 V

Resistance measurement in the presence of noise of 50 Hz or 60 Hz

- signal/noise ratio	Additional uncertainty	Signalling
N ≥ 0.02	-	-
0.02 > N ≥ 0.004	1%	
N < 0.004	unspecified	

Measuring current settings
Resistance measurements of resistive objects: 1 mA, 10 mA, 100 mA, 1 A, 10 A
Resistance measurements of inductive objects: 1 mA, 10 mA, 100 mA, 1 A, 10 A

10.2 Other technical data

a) insulation type acc. to EN 61010-1 ..... double
b) measurement category acc. to EN 61010-2-030 ..... III 600 V

NOTE!

With the use of 10 m or 25 m measurement leads with the crocodile - CAT III 50 V.

c) ingress protection acc. to EN 60529
- with closed housing IP67
- with open housing, powered from the battery pack, installed plugs IP54
- with open housing, powered from mains and/or without plugs IP40

d) protection against external voltage ..... up to 600 Vac for 10 s
e) power supply ..... Li-Ion rechargeable battery 7.2 V 8.8 Ah
f) power supply to battery charger ..... 90 V..265 V/50 Hz..60 Hz, 2 A
g) battery charging time ..... approximately 3.5 hours
h) number of measurements (of resistance objects) with 10A current performed when powered from the battery pack ..... 700..800, depending on the ambient temperature
i) maximum wire resistance for 10A current ..... 300 mΩ
j) accuracy of measuring current setting: ..... ±10%
k) time of performing the resistance measurement:
- with selected resistive object type and bidirectional current flow ..... 3 s
- with selected inductive object type, dependent on the resistance and inductance of the object..... ..... 5 s or more

l) dimensions ..... 318 mm x 257 mm x 152 mm
m) meter weight ..... approx. 3,5 kg
n) operating temperature ..... -10°C…+50°C
o) charger operating temperature ..... 0°C…+45°C
p) storage temperature ..... -20°C…+60°C
q) humidity ..... 20%…90%
r) reference temperature ..... +23°C ± 2°C
s) reference humidity ..... 40%…60%
t) altitude (above sea level): ..... <2000 m
u) temperature coefficient ..... ±0.01% of d.v./ °C ±0.1 digit / °C
v) time to AUTO-OFF ..... 5…45 minutes or option not active, depending on the setting
w) TFT graphic display ..... 800x480 points
x) interface standard ..... USB, LAN
y) quality standard, ... design and manufacturing are ISO 9001 compliant
z) the product meets the EMC requirements (emission for industrial environment) according to: .... EN 61326-1 and EN 61326-2-2

- The LAN port may be used to communicate with an external system. This function is optional, available on special order.
- SONEL S.A. hereby declares that the radio device type MMR-650 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/

11 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

SYMBOLS DISPLAYED BY THE METER

Memory

Settings

Return to the main menu

Help

Adding a client, object or measuring point

Searching for an object or measurement point

Entry to client objects

Entry to client edition, object or measurement point with a possibility of changing data

Fast entry deletion on the on-screen keyboard

Deletion of a measurement point, object or client

Measuring Mode

Recording mode

Measurement setup mode

Saving to memory

Report print

Temperature measurement, reference temperature

Presentation of measurement results in the form of a time chart

Exit from the option

Wi-Fi signal strength

There was a limitation of the measuring current to a value lower than that ensuring maximum accuracy

Test leads interchanged

High level of noise (interference), measurement possible with additional uncertainty

High level of noise (interference), measurement possible without defining uncertainty

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