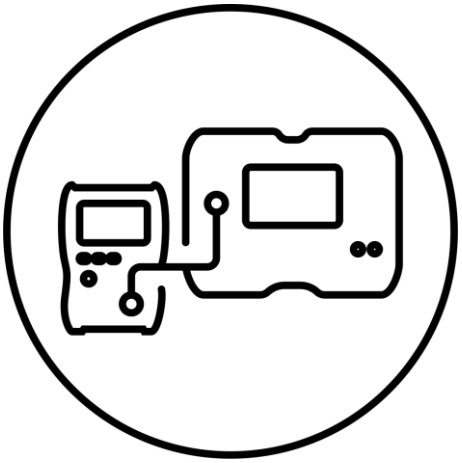
User manual

MeasureEffect

Sonel measurement platform



User manual

MeasureEffect

Sonel measurement platform

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MeasureEffect™

Welcome to the **Sonel MeasureEffect™** platform. It is a comprehensive system that enables you to take measurements, store and manage data, and provides multi-level control of your instruments.

In this document, we have described all the functions of the platform. Your meter's functionalities may be narrower.

CONTENTS

1 Interface and configuration

1.1 On-screen keyboard

The on-screen keyboard has the same functions as the keyboard on any touchscreen device.

	Delete
	Go to new line
	Go to the next field
!#1	Switch to a keyboard with numbers and special characters
Alt	Show diacritics
	Confirm the entered text
	Hide the keyboard

1.2 Menu icons

General			
	Go to the previous window		Expand the item
	Return to the main menu		Collapse the item
	Help		Save
	Log out the user		Close window / cancel the action
			Information
Measurements			
+/-	Enter the markings		Start the measurement
	Add a measurement object		Finish the measurement
	Measurement settings and limits		Repeat the measurement
			Show the graph
Memory			
	Add an object		Search
	Add a folder		Go to the parent folder
	Add an instrument		
	Add a measurement		

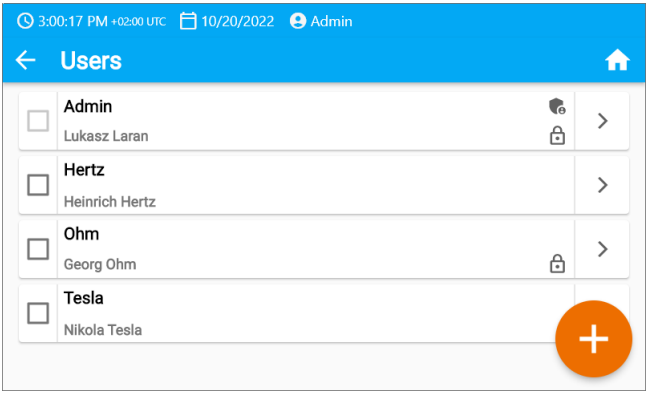
1.3 Gestures

Start the measurement by holding the icon for 5 seconds

Touch an item on the touch screen

1.4 User's account

After logging in, you will gain access to the user accounts menu. The padlock symbol means that the user is protected by a password.



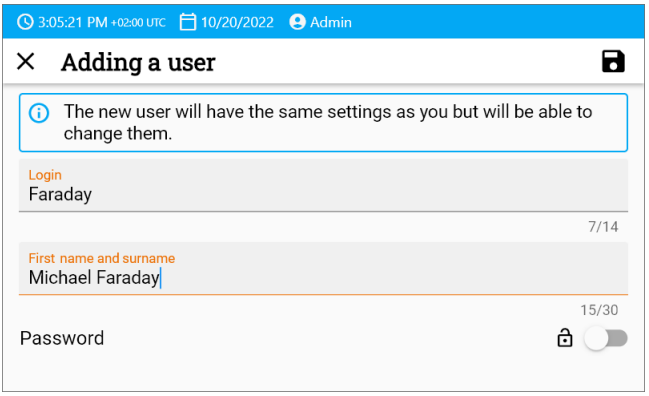
Users are introduced to a list of people, who performed tests using their signature name. The device can be used by a number of people. Every person can log in as a user with their own login and password. Passwords are used to prevent logging into another users account. Only the **administrator** has the right to enter and delete users. **Other users** can only change their own data.

- The meter can have only one administrator (admin) and a maximum of 4 users with limited rights.
- The user created by the administrator receives their own meter settings.
- These settings can only be changed by that user and the administrator.

1.4.1 Adding and editing users

1

- To enter a new user, select  .
- To change the data of a given user, select the user.
- Then enter or edit its data.



2  After touching the padlock, you can enter the password to access the user account. Touch it again if you want to disable the account password protection.

3  Finally, save your changes.

1.4.2 Deleting users

To delete users, mark them and select  . The exception is the administrator account, which can only be deleted by restoring the meter to the factory settings (**sec. 1.5.3**).

1.4.3 Switching users

1  To change the user, log out the current user and confirm the ending of the session.

2  Now you can log in as another user.

1.5 Configuration of the meter – main settings

Here you can configure the meter to your needs.

1.5.1 Language

Here you can set the interface language.

1.5.2 Date and time

Available settings:

- **Date.**
- **Time.**
- **Time zone.**

1.5.3 Meter

Available settings:

- **Communication** – here you can configure the available communication methods.
- **Display** – here you can turn on/off the time for when the screen will turn off, adjust the brightness, turn on/off the touch function of the screen, change the size of fonts and icons in the measurement view.
- **Sounds** – here you can turn on/off the system sounds.
- **Specialized mode** – allows you to enter a special service code. This functionality is dedicated to our technical support.
- **Recovery** – here you can restore the meter to factory settings. See also **sec. 1.5.6**.
- **Meter status** – here you can check the used and available space in the internal memory.

1.5.4 Measurements

Available settings:

- **Show messages about high voltage** – displaying additional messages about high voltage while taking measurements.
- **ID auto increment** – creating new memory items with a unique ID for the parent folder in sequential numbering.
- **Name auto increment** – creating new memory items according to previously selected names and types.
- **Temperature unit** – setting the unit of temperature displayed and stored in the result after connecting the temperature probe.

1.5.5 Information

Here you can check information about the meter.

1.5.6 Factory reset of the meter

You have several options in this menu.

- **Meter memory optimization**. Use this function, if:
  ⇒ there are problems with saving or reading measurements,
  ⇒ there are problems navigating through folders.
  If this method does not correct the problem, use the "Reset the meter's memory" function.

- **Resetting the meter's memory**. Use this function, if:
  ⇒ restoring the meters memory did not correct the problem.
  ⇒ there are other problems preventing the use of the memory
  Before starting the deletion, we recommend that you transfer the data to a USB stick or a computer.

- **Factory reset of the meter**. All saved folders, measurements, user accounts and entered settings will be deleted.

After selecting the desired option, confirm your decision and follow the prompts.

2 First steps

2.1 List of measurement functions

The list of available measurement functions varies depending on what is connected to the device.

- After connecting the AutoISO adapter, the list of available measurement functions will be narrowed down to those dedicated to the adapter.

2.2 Measurement settings

+/- In the measurement menu, you can enter or edit the markings of wire pairs in the tested object. The names (marking) may be:

- predefined,
- defined by user (after selecting **Use your own wire markings**).

+/-
L1/L2
… The label icons lead to the labelling window of a pair of lines. The new markings cannot be the same as those already introduced.

The icon opens the window for adding the measurement of the next pair of conductors.

Tests require appropriate settings. To do this, select this icon in the measurement window. A menu will open with parameter settings (different items depend on the selected measurement).

If you have set limits, the meter will show if the result are within them.

 – the result is within the set limit.

 – the result is outside the set limit.

 – assessment not possible.

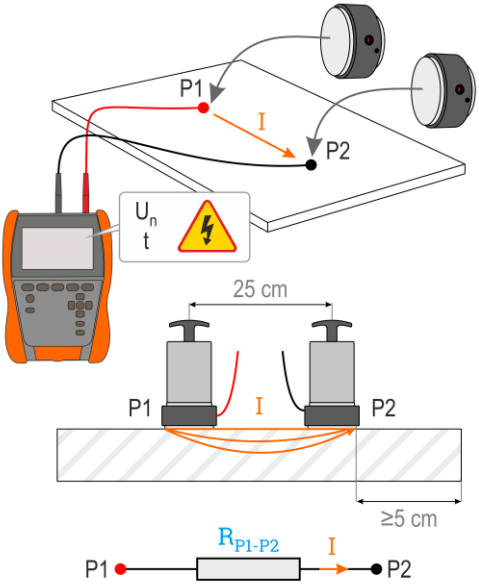
3 Connections

3.1 Electrical safety

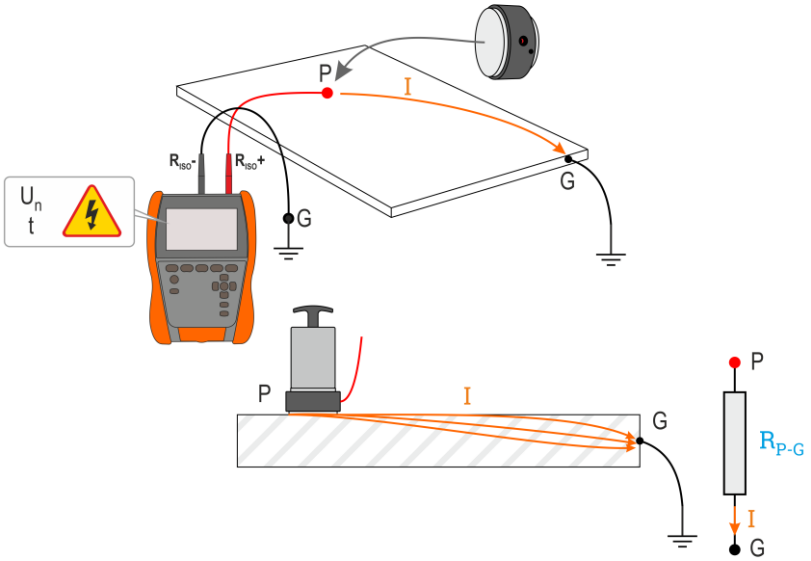
3.1.1 Connections for EPA measurements

The connection layouts vary depending on what you want to measure.

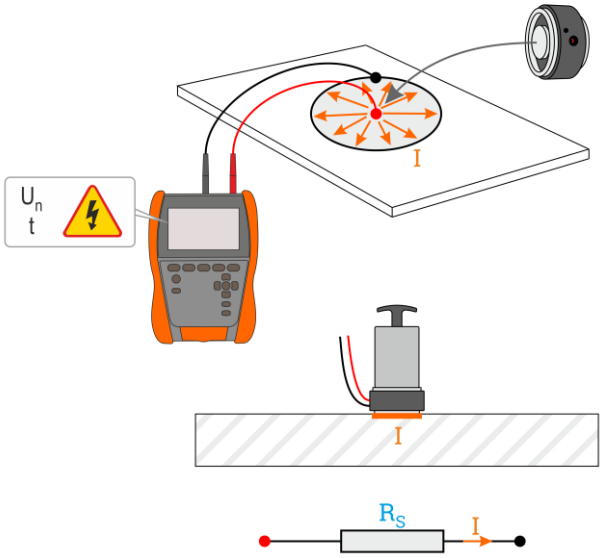
3.1.1.1 Point-to-point resistance – R_{P1-P2}



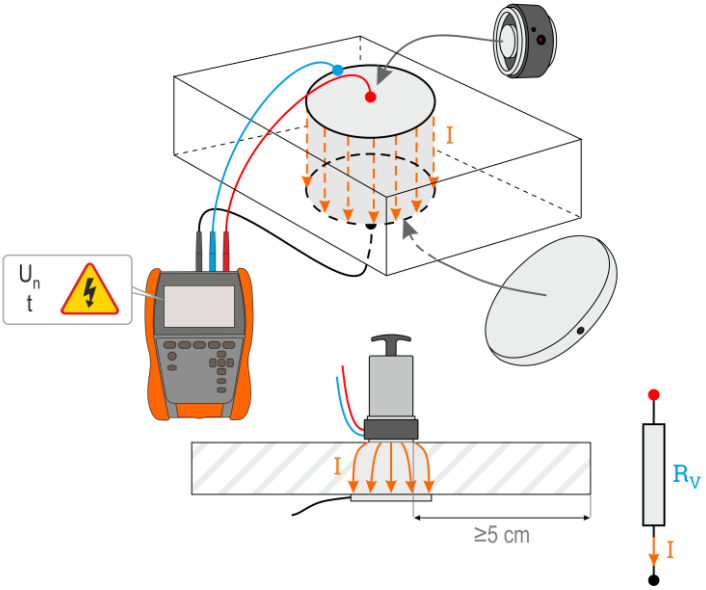
3.1.1.2 Point-to-ground resistance – R_{P-G}



3.1.1.3 Surface resistance – R_S



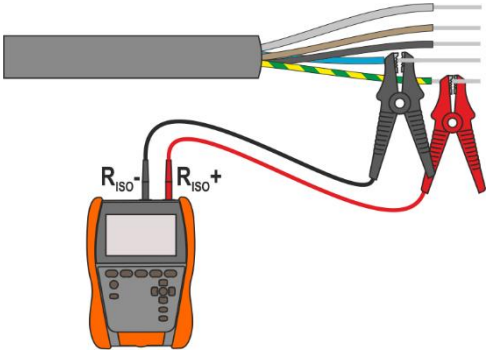
3.1.1.4 Volume resistance – R_V



3.1.2 Connections for R_{ISO} measurements

During the measurement, **make sure that test leads and crocodile clips do not touch each other and/or ground**, because such a contact may cause the flow of surface currents resulting in additional error in measurement results.

The standard way of measuring the insulation resistance (R_{ISO}) is the two-lead method.



In case of power cables measure the insulation resistance between each conductor and other conductors shorted and grounded (**Fig. 3.1**, **Fig. 3.2**). In shielded cables, the shield is also shorted.

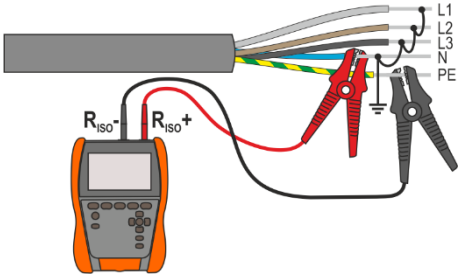


Fig. 3.1. Measurement of an unshielded cable

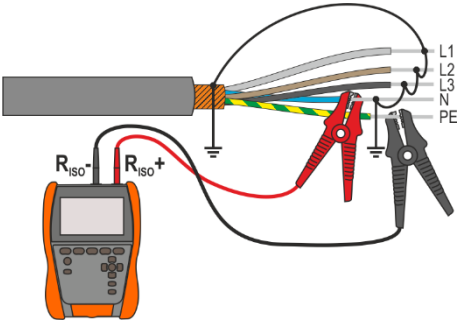
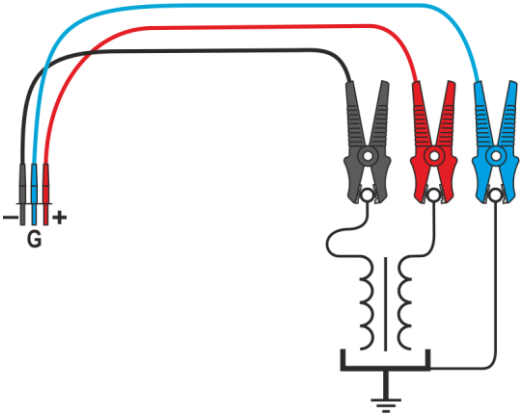


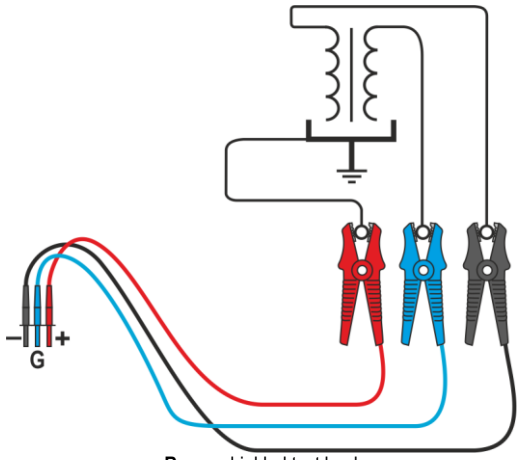
Fig. 3.2. Measurement of a shielded cable

In transformers, cables, insulators, etc. there is **surface resistance** that can distort the measurement result. To **eliminate** it, a three-lead measurement with **G** – GUARD socket is used. An example of the application of this method is presented below.



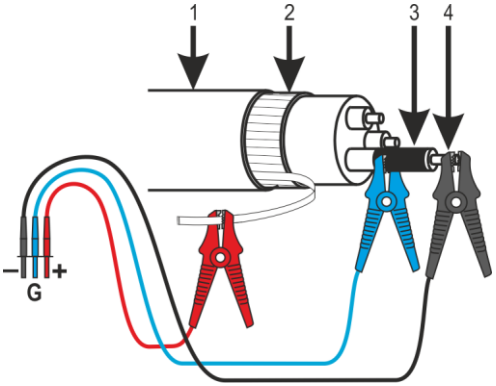
R_{ISO}**-** – shielded test lead

Measurement of inter-winding resistance of a transformer. Connect **G** socket to the transformer tank, and R_{ISO}**+** and R_{ISO}**-** sockets to the windings.



R_{ISO}**-** – shielded test lead

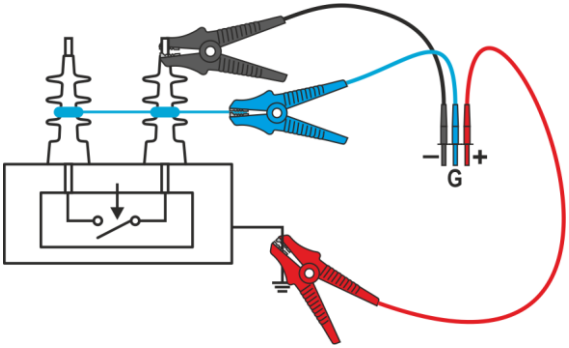
Measurement of insulation resistance between one of the windings and the transformer tank. **G** socket of the meter should be connected to the second winding, and R_{ISO}**+** socket to the ground potential.



R_{ISO-} – shielded test lead
1 – cable jacket
2 – cable shield
3 – metal foil wrapped around conductor's insulation
4 – conductor

Measurement of cable insulation resistance between one of cable conductors and its shield. The effect of surface currents (important in adverse weather conditions) is eliminated by connecting a piece of metal foil insulating the tested conductor with **G** socket of the meter.

The same shall apply when measuring the insulation resistance between two conductors of the cable - other conductors that do not take part in the measurement are attached to **G** terminal.

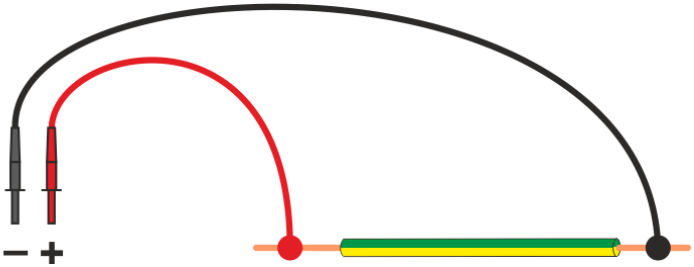


R_{ISO-} – shielded test lead

Insulation resistance measurement of high voltage breaker. G socket of the meter is connected with the insulators of disconnector terminals.

3.1.3 Connections for R_X, R_{CONT} measurements

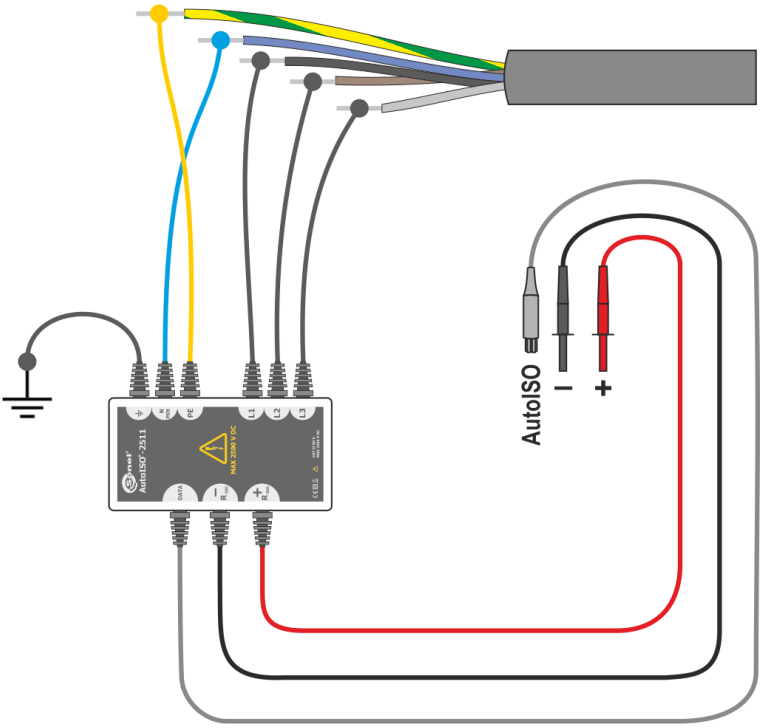
Low-voltage measurement of resistance is carried out in the following circuit.



3.1.4 Measurements using the AutoISO-2511 adapter

Depending on the measurement facility and the established standards (each conductor to each or conductor to other shorted and grounded conductors), the measurement of the insulation resistance of wires or multi-core cables requires several connections. In order to shorten the measurement time and eliminate the inevitable connection errors, Sonel recommends an adapter that switches between individual pairs of conductors for the operator.

The AutoISO-2511 adapter is designed to measure the insulation resistance of cables and multi-core wires with a measuring voltage of up to 2500 V. The use of the adapter eliminates the possibility of making a mistake, and significantly reduces the time needed to measure the insulation resistance between pairs of conductors. For example, for 4-core cables, the user will perform only one connection operation (i.e. connect the adapter to the facility), while the AutoISO-2511 will perform the crossing for six consecutive connections.



4 Measurements. Visual test

1  Select **Visual test**.

2 From the list of options that can be used, select the result of your inspection. Touch each item as many times as is needed to enter the appropriate test result:

– not performed,
– passed,
– failed,
– undefined (no clear assessment),
– not applicable (not applicable to a given aspect),
– omitted (intentional, deliberate omission, e.g. due to no access).

 If any option you need is missing, you can add it to the list.

3  End the test.

4 The test summary screen will appear. Touching the bar with the result will reveal your selections from **step 2**. If you want to enter additional information about the study, expand the **Attachments** field and fill in the comment field.

5 Measurements. Electrical safety

5.1 DD – Dielectric Discharge Indicator

The purpose of the test is to check the degree of moisture in the insulation of the tested object. The greater its moisture content, the greater the dielectric discharge current.

In the dielectric discharge test, after 60 seconds from the end of measurement (charging) of the insulation, the discharge current is measured. The DD is a value characterising the insulation quality independent from the test voltage.

The measurement operates in the following way:

- First the insulation is charged with a current for a set period. If the voltage is not equal to the set voltage, the object is not charged and the meter abandons the measurement procedure after 20 seconds.
- After the charging and polarisation is complete, the only current flowing through the insulation is the leakage current.
- Then the insulation is discharged and the total dielectric discharge current starts to flow through the insulation. Initially this current is the sum of the capacitance discharge current, which fades quickly with the absorption current. The leakage current is negligible, because there is no test voltage.
- After 1 minute from closing the circuit the current is measured.

The DD value is calculated using the formula:

$$DD = \frac{I_{1\min}}{U_{pr} \cdot C}$$

where:
I_{1min} – current measured 1 minute after closing the circuit [nA],
U_{pr} – test voltage [V],
C – capacitance [µF].

The measurement result indicates the status of the insulation. It may be compared with the following table.

DD value	Insulation condition	
>7	Bad	
4-7	Weak	
2-4	Acceptable	
<2	Good	

To take a measurement, you must set (⚙):

- nominal test voltage **U_n**,
- total duration of the measurement **t**,
- limits (if necessary).

The meter will suggest possible settings.

1 

- Select **DD** measurement.
- Enter the measurement settings (**sec. 2.2**).

2 Connect test leads according to **sec. 3.1.2**.

3

5 s

Press and hold **START** button for **5 seconds.** This will trigger a 5-second countdown, after which the measurement will **start**.

Quick start (without a delay of 5 seconds) perform by sliding the **START** button.

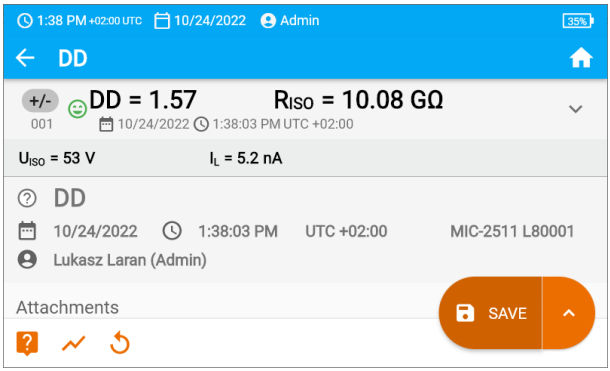
Testing will continue **until it reaches the preset time** or until is pressed.

Touching the bar with the result reveals partial results.

During the measurement, it is possible to display the graph (**sec. 6.1**).

4

After the measurement is completed, you can read the result. Touching the bar with the result will now also reveal partial results.



You can now also display the graph (**sec. 6.1**).

5

You may do the following with the measurement result:

ignore and exit to the measurement menu,

repeat it (the selection window for the measurement you want to repeat will be shown),

SAVE – save to memory,

SAVE AND ADD – create a new folder/device which is equivalent to the folder/device where the result of the previously performed measurement was saved,

SAVE TO THE PREVIOUS ONE – save the result in the folder/device where the result of the previously performed measurement was saved.

In environments with strong electromagnetic interferences the measurement may be affected by an additional error.

5.2 EPA – measurements in the EPAs

In EPAs (Electrostatic Protected Areas) materials for protection against electrostatic discharge (ESD) are used. They are classified according to their resistance and resistivity characteristics.

ESD shielding materials – full protection of this type is provided by a Faraday cage. An important material shielding from static discharges is conductive metal or carbon, which suppresses and weakens the energy of the electric field.

Conductive materials – have low resistance, enabling the charges to move quickly. If the conductive material is grounded, charges flow away quickly. Examples of conductive materials: carbon, metals-conductors.

Charge-dissipating materials – in these materials, charges flow to the ground more slowly than in the case of conductive materials, their destructive potential is reduced.

Insulating materials – difficult to ground. Static charges remain in this type of material for a long time. Examples of insulating materials: glass, air, commonly used plastic packaging.

Material	Criteria
ESD discharge shielding materials	$R_V > 100\ \Omega$
Conductive materials	$100\ \Omega \le R_S < 100\ k\Omega$
Charge dissipating materials	$100\ k\Omega \le R_V < 100\ G\Omega$
Insulating materials	$R_S \ge 100\ G\Omega$

To take a measurement, you must set ( ):
- test voltage $\mathbf{U_n}$ – according to EN 61340-4-1: 10 V / 100 V / 500 V,
- measurement duration **t** – according to EN 61340-4-1: 15 s ± 2 s,
- measurement method:
  - ⇒ point-to-point resistance – $\mathbf{R_{P1-P2}}$,
  - ⇒ point-to-ground resistance – $\mathbf{R_{P-G}}$,
  - ⇒ surface resistance – $\mathbf{R_S}$,
  - ⇒ volume resistance – $\mathbf{R_V}$.
- limits – see evaluation criteria according to EN 61340-5-1 (table below).

Material	Criteria
Surfaces	$R_{P-G} < 1\ G\Omega$ $R_{P1-P2} < 1\ G\Omega$
Floors	$R_{P-G} < 1\ G\Omega$
Conductive packaging	$100\ \Omega \le R_S < 100\ k\Omega$
Load-dissipating packaging	$100\ k\Omega \le R_S < 100\ G\Omega$
Insulating packaging	$R_S \ge 100\ G\Omega$

Detailed guidelines can be found in the standards: IEC 61340-5-1, IEC/TR 61340-5-2, ANSI/ ESD S20.20, ANSI/ESD S541 and in the standards referred to in the above-mentioned documents.

1

- Select **EPA** measurement.
- Select the measurement method (**sec. 2.2**).
- Enter the measurement settings (**sec. 2.2**).

2

Connect the measurement system according to the adopted measurement method (**sec. 3.1.1**).

3

5 s

Press and hold **START** button for **5 seconds.** This will trigger a 5-second countdown, after which the measurement will **start**.

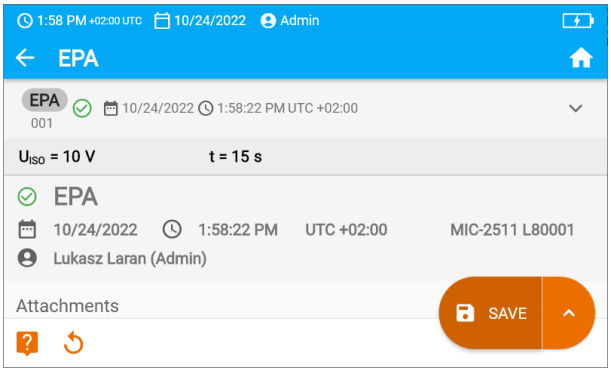
Quick start (without a delay of 5 seconds) perform by sliding the **START** button.

Testing will continue **until it reaches the preset time** or until is pressed.

Touching the bar with the result reveals partial results.

4

After the measurement is completed, you can read the result. Touching the bar with the result will now also reveal partial results.



5

You may do the following with the measurement result:

ignore and exit to the measurement menu,

repeat it (the selection window for the measurement you want to repeat will be shown),

SAVE – save to memory,

SAVE AND ADD – create a new folder/device which is equivalent to the folder/device where the result of the previously performed measurement was saved,

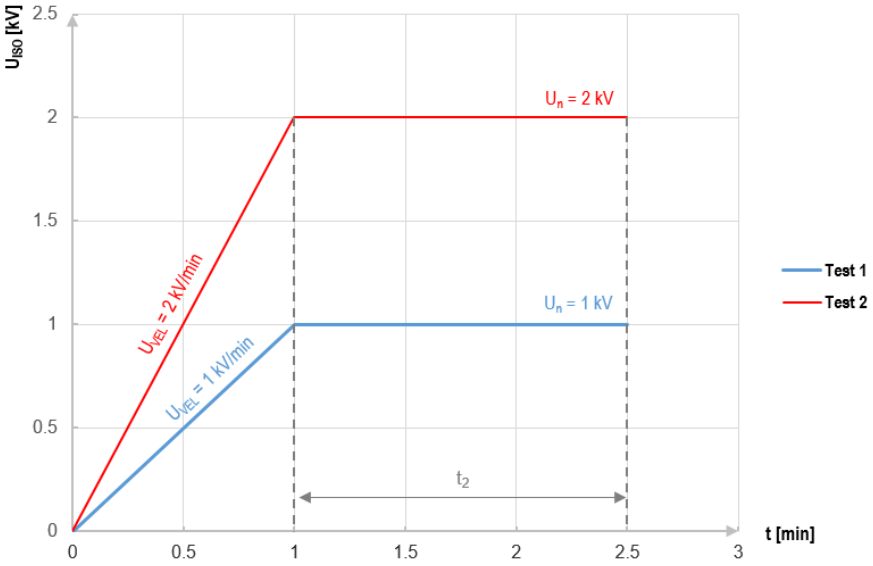
SAVE TO THE PREVIOUS ONE – save the result in the folder/device where the result of the previously performed measurement was saved.

5.3 RampTest – measurement with ramp test

Measurement with increasing voltage (RampTest) is to determine at which DC voltage value the insulation will (or will not) break down. The essence of this function is:

- to test the measured object with the voltage increasing to the final value $\mathbf{U_n}$,
- to check if the object will retain electrical insulating properties when the maximum voltage $\mathbf{U_n}$ is present there for the preset time $\mathbf{t_2}$.

The measuring procedure is illustrated in the graph below.



Graph 5.1. Voltage supplied by the meter as a function of time for two exemplary increase rates

To perform the measurement, first set ( ):

- voltage $\mathbf{U_n}$ – voltage at which the rise is to end. It can be within the range of 50 V…U_{MAX},
- time **t** – total duration of the measurement,
- time $\mathbf{t_2}$ – time during which the voltage should be maintained on the tested object (**Graph 5.1**),
- maximum short-circuit current $\mathbf{I_{SC}}$ – if during the measurement the meter **reaches the preset value** it will enter the mode of current limit, which means that **it will stop further increase** of forced current on this value,
- leakage current limit $\mathbf{I_L}$ ($\mathbf{I_L \leq I_{SC}}$) – if the measured leakage current **reaches the preset value** (a breakdown of the tested object occurs), the measurement is **stopped** and the meter displays the voltage at which it occurred.

1

- Select **RampTest** measurement.
- Enter the measurement settings (**sec. 2.2**).

2 Connect test leads according to **sec. 3.1.2**.

3

5 s

Press and hold **START** button for **5 seconds.** This will trigger a 5-second count-down, after which the measurement will **start**.

Quick start (without a delay of 5 seconds) perform by sliding the **START** button.

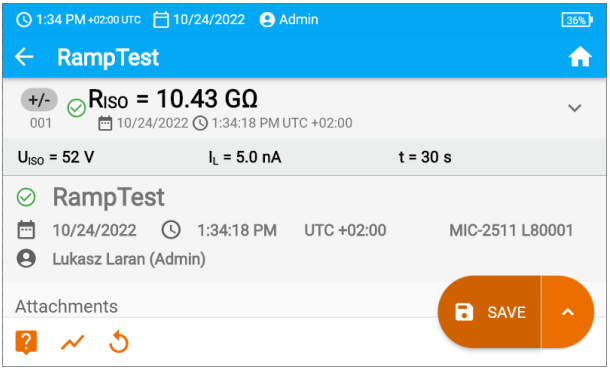
Testing will continue **until it reaches the preset time** or until is pressed.

Touching the bar with the result reveals partial results.

During the measurement, it is possible to display the graph (**sec. 6.1**).

4

After the measurement is completed, you can read the result. Touching the bar with the result will now also reveal partial results.



You can now also display the graph (**sec 6.1**).

5

You may do the following with the measurement result:

ignore and exit to the measurement menu,

repeat it (the selection window for the measurement you want to repeat will be shown),

SAVE – save to memory,

▶ **SAVE AND ADD** – create a new folder/device which is equivalent to the folder/device where the result of the previously performed measurement was saved,

▶ **SAVE TO THE PREVIOUS ONE** – save the result in the folder/device where the result of the previously performed measurement was saved.

5.4 R_{ISO} – insulation resistance

The instrument measures the insulation resistance by applying the measuring voltage U_n to the tested resistance R and measuring the current I flowing through it. When calculating the value of the insulation resistance, the meter uses the technical method of resistance measurement (R = U/I).

To take a measurement, you must set ( ):

- nominal test voltage **U_n**,
- duration of the measurement **t** (if allowed by the hardware platform),
- times **t_1**, **t_2**, **t_3** needed for calculating absorption coefficients (if allowed by the hardware platform),
- limits (if necessary).

The meter will suggest possible settings.

5.4.1 Measurements with the use of test leads

1

- Select **R_{ISO}** measurement.
- Enter the measurement settings (**sec. 2.2**).

2

Connect test leads according to **sec. 3.1.2**.

3

5 s

Press and hold the **START** button for **5 seconds.** This will trigger a countdown, during which the meter does not generate a dangerous voltage, and the measurement can be interrupted without the need to discharge the tested object. After the countdown, the measurement will **start**.

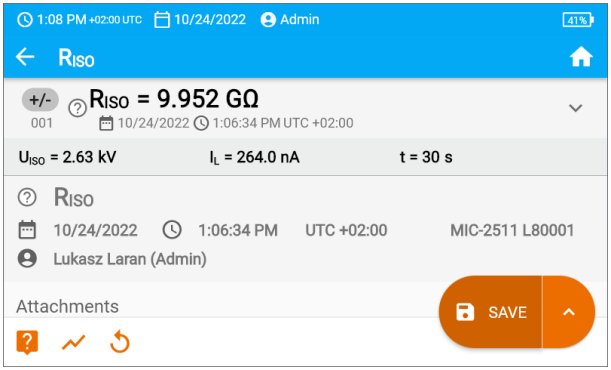
Quick start (without a delay of 5 seconds) perform by sliding the **START** button.

Testing will continue **until it reaches the preset time** or until is pressed.

Touching the bar with the result reveals partial results.

During the measurement, it is possible to display the graph (**sec. 6.1**).

4 After the measurement is completed, you can read the result. Touching the bar with the result will now also reveal partial results.



U_{ISO} – test voltage
I_L – leakage current

You can now also display the graph (**sec 6.1**).

5 You may do the following with the measurement result:

ignore and exit to the measurement menu,

repeat it (the selection window for the measurement you want to repeat will be shown),

SAVE – save to memory,

SAVE AND ADD – create a new folder/device which is equivalent to the folder/device where the result of the previously performed measurement was saved,

SAVE TO THE PREVIOUS ONE – save the result in the folder/device where the result of the previously performed measurement was saved.

- Disabling t_2 time will also disable t_3.
- The timer measuring the measurement time is started when U_{ISO} voltage is stabilized.
- **LIMIT I** informs of an operation with limited inverter power. If this condition persists for 20 seconds, the measurement is stopped.
- If the meter is unable to charge the capacitance of the tested object, **LIMIT I** is displayed and after 20 s **the measurement is stopped**.
- A short tone informs for every period of 5 seconds of time that has lapsed. When the timer reaches characteristic points (t_1, t_2, t_3 times), then for 1 second, an icon of this point is displayed which is accompanied by a long beep.
- If the value of any of the measured partial resistance is out of range, then the value of the absorption coefficient is not shown and horizontal dashes are displayed.
- After completion of the measurement, the capacitance of the tested object is discharged by shorting **R_{ISO}+** and **R_{ISO}-** terminals with resistance of ca. 100 kΩ. At the same time, the message **DISCHARGING** is displayed, as well as the value of U_{ISO} voltage that is present at that time on the object. U_{ISO} decreases over time until it is fully discharged.

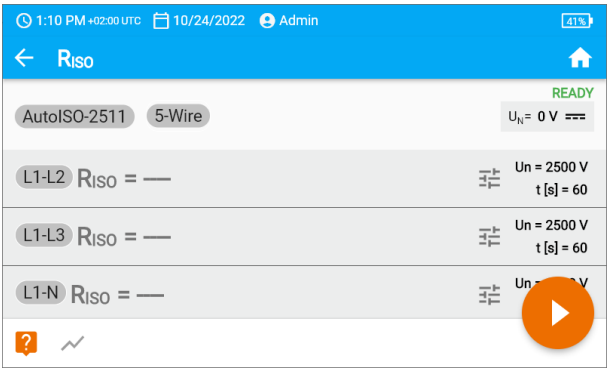
5.4.2 Measurements using the AutoISO-2511 adapter

1 Select R_{ISO} measurement.

2 Connect the adapter according to **sec. 3.1.4**.

After connecting the adapter, the list of available measurement functions will be narrowed down to those dedicated to the adapter.

3 The screen displays the label of the connected adapter and the icon for selecting the number of wires of the tested object.



- Determine the number of wires of the tested object.
- For each pair of conductors enter the measurement settings (**sec. 2.2**).

4 Connect the adapter to the tested object.

5 5 s

Press and hold the **START** button for **5 seconds.** This will trigger a countdown, after which the measurement will **start**.

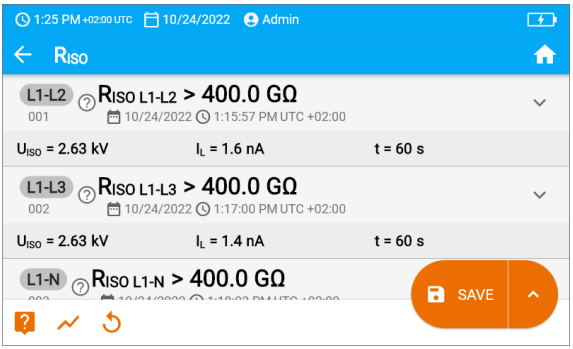
Quick start (without a delay of 5 seconds) perform by sliding the **START** button.

Testing will continue **until it reaches the preset time** or until is pressed.

Touching the bar with the result reveals partial results.

During the measurement, it is possible to display the graph (**sec. 6.1**).

6 After the measurement is completed, you can read the result. Touching the bar with the result will now also reveal partial results.



U_{ISO} – test voltage
I_L – leakage current

You can now also display the graph (**sec. 6.1**).

7 You may do the following with the measurement result:

ignore and exit to the measurement menu,

repeat it (the selection window for the measurement you want to repeat will be shown),

SAVE – save to memory,

SAVE AND ADD – create a new folder/device which is equivalent to the folder/device where the result of the previously performed measurement was saved,

SAVE TO THE PREVIOUS ONE – save the result in the folder/device where the result of the previously performed measurement was saved.

- Disabling t_2 time will also disable t_3.
- The timer measuring the measurement time is started when U_{ISO} voltage is stabilized.
- **LIMIT I** informs of an operation with limited inverter power. If this condition persists for 20 seconds, the measurement is stopped.
- If the meter is unable to charge the capacitance of the tested object, **LIMIT I** is displayed and after 20 s **the measurement is stopped**.
- A short tone informs for every period of 5 seconds of time that has lapsed. When the timer reaches characteristic points (t_1, t_2, t_3 times), then for 1 second, an icon of this point is displayed which is accompanied by a long beep.
- If the value of any of the measured partial resistance is out of range, then the value of the absorption coefficient is not shown and horizontal dashes are displayed.
- After completion of the measurement, the capacitance of the tested object is discharged by shorting **R_{ISO}+** and **R_{ISO}-** terminals with resistance of ca. 100 kΩ. At the same time, the message **DISCHARGING** is displayed, as well as the value of U_{ISO} voltage that is present at that time on the object. U_{ISO} decreases over time until it is fully discharged.

5.5 R_{ISO} 60 s – Dielectric Absorption Ratio (DAR)

The dielectric absorption ratio (DAR) determines the state of insulation through the ratio of the measured resistance value at the two moments of measurement (R_{t1}, R_{t2}).

- Time t_1 is the 15th or 30th second of measurement.
- Time t_2 is the 60. second of measurement.

The DAR value is calculated using the formula:

$$DAR = \frac{R_{t2}}{R_{t1}}$$

where:
R_{t2} – resistance measured at time t_2,
R_{t1} – resistance measured at time t_1.

The measurement result indicates the status of the insulation. It may be compared with the following table.

DAR value	Insulation condition	
<1	Bad	
1-1,39	Undetermined	
1,4-1,59	Acceptable	
>1,6	Good	

To take a measurement, you must set ( ):

- Test voltage **U_n**,
- time **t_1**.

1 

- Select **DAR (R_{ISO} 60 s)** measurement.
- Enter the measurement settings (**sec. 2.2**).

2 Connect test leads according to **sec. 3.1.2**.

3 

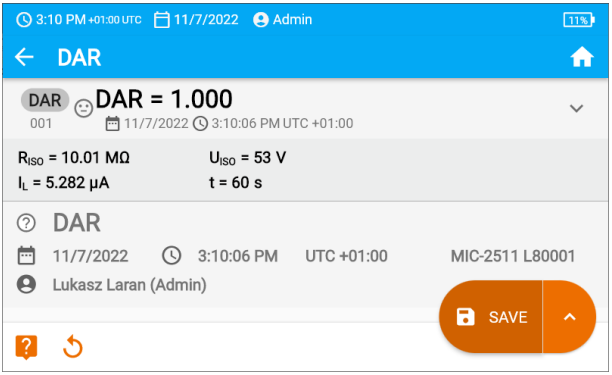
Press and hold the **START** button for **5 seconds.** This will trigger a countdown, during which the meter does not generate a dangerous voltage, and the measurement can be interrupted without the need to discharge the tested object. After the countdown, the measurement will **start**.

Quick start (without a delay of 5 seconds) perform by sliding the **START** button.

Testing will continue **until it reaches the preset time** or until  is pressed.

Touching the bar with the result reveals partial results.

4 After the measurement is completed, you can read the result. Touching the bar with the result will now also reveal partial results.



5 You may do the following with the measurement result:

ignore and exit to the measurement menu,

repeat it (the selection window for the measurement you want to repeat will be shown),

SAVE – save to memory,

▶ **SAVE AND ADD** – create a new folder/device which is equivalent to the folder/device where the result of the previously performed measurement was saved,

▶ **SAVE TO THE PREVIOUS ONE** – save the result in the folder/device where the result of the previously performed measurement was saved.

5.6 R_{ISO} 600 s – Polarization Index (PI)

The polarization index (PI) determines the state of insulation through the ratio of the measured resistance value at the two moments of measurement (R_{t1}, R_{t2}).

- Time t_1 is the 60th second of measurement.
- Time t_2 is the 600th second of measurement.

The PI value is calculated using the formula:

$$PI = \frac{R_{t2}}{R_{t1}}$$

where:
R_{t2} – resistance measured at time t_2,
R_{t1} – resistance measured at time t_1.

The measurement result indicates the status of the insulation. It may be compared with the following table.

PI value	Insulation condition	
<1	Bad	
1-2	Undetermined	
2-4	Acceptable	
>4	Good	

To perform a measurement, first set ( ) measurement voltage **U_n**.

1 

- Select **PI (R_{ISO} 600 s)** measurement.
- Enter the measurement settings (**sec. 2.2**).

2 Connect test leads according to **sec. 3.1.2**.

3 

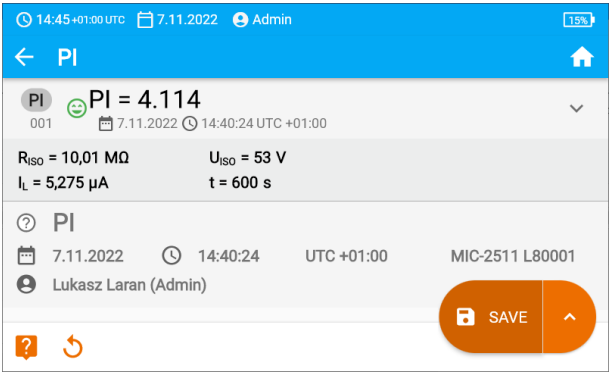
Press and hold the **START** button for **5 seconds.** This will trigger a countdown, during which the meter does not generate a dangerous voltage, and the measurement can be interrupted without the need to discharge the tested object. After the countdown, the measurement will **start**.

Quick start (without a delay of 5 seconds) perform by sliding the **START** button.

Testing will continue **until it reaches the preset time** or until is pressed.

Touching the bar with the result reveals partial results.

4 After the measurement is completed, you can read the result. Touching the bar with the result will now also reveal partial results.



5 You may do the following with the measurement result:

ignore and exit to the measurement menu,

repeat it (the selection window for the measurement you want to repeat will be shown),

SAVE – save to memory,

▶ **SAVE AND ADD** – create a new folder/device which is equivalent to the folder/device where the result of the previously performed measurement was saved,

▶ **SAVE TO THE PREVIOUS ONE** – save the result in the folder/device where the result of the previously performed measurement was saved.

The polarization index value obtained during a measurement in which R_{t1} > 5 GΩ should not be taken as a reliable assessment of insulation condition.

5.7 R_X, R_{CONT} – low-voltage measurement of resistance

5.7.1 Calibration of test leads

In order to eliminate the impact of the resistance of test leads on measurement result, the compensation (nulling) of their resistance may be performed.

1 

Select **Autozero**.

2a 

Short the test leads. The meter will measure the resistance of test leads three times. It will then provide the **result decreased** by this resistance, while the resistance measurement window will show the massage **Autozero (On)**.

3b 

To **disable compensation** of the resistance of leads, repeat **step 2** with **open test leads** and press . Then the measurement result will **contain the resistance of test leads**, while the resistance measurement window will show the massage **Autozero (Off)**.

5.7.2 R_X – measurement of resistance

1 

Select R_X measurement.

2 Connect test leads according to **sec. 3.1.3**.

3 

Measurement starts automatically and lasts continuously.

5.7.3 R_{CONT} – measurement of resistance of protective conductors and equipotential bonding with ±200 mA current

1

- Select **R_{CONT}** measurement.
- Enter the measurement settings (**sec. 2.2**).

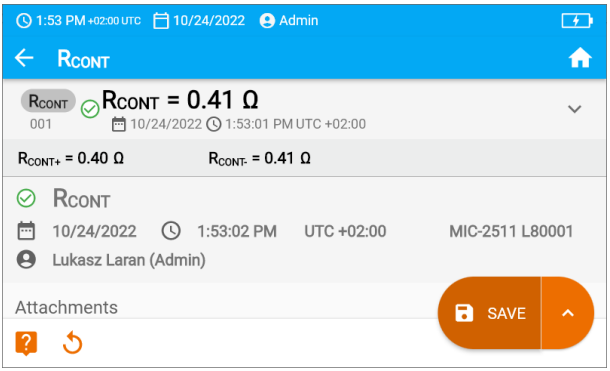
2 Connect test leads according to **sec. 3.1.3**.

3 Press **START**.

Testing will continue **until it reaches the preset time** or until is pressed.

Touching the bar with the result reveals partial results.

4 After the measurement is completed, you can read the result. Touching the bar with the result will now also reveal partial results.



The result is the arithmetic mean of the values of two measurements at a current of 200 mA with opposite polarities: **R_{CONT+}** and **R_{CONT-}**.

$$R = \frac{R_{CONT+} + R_{CONT-}}{2}$$

5 You may do the following with the measurement result:

ignore and exit to the measurement menu,

repeat it (the selection window for the measurement you want to repeat will be shown),

SAVE – save to memory,

▶ 

SAVE AND ADD – create a new folder/device which is equivalent to the folder/device where the result of the previously performed measurement was saved,

▶ 

SAVE TO THE PREVIOUS ONE – save the result in the folder/device where the result of the previously performed measurement was saved.

5.8 SPD – testing surge protecting devices

SPDs (*surge protecting devices*) are used in facilities with and without lightning protection installations. They ensure the safety of the electrical installation in the event of an uncontrolled voltage surge in the network, e.g. due to lightning. SPDs for protecting electrical installations and devices connected to them are most often based on varistors or spark gaps.

Varistor type surge protecting devices are subject to aging processes: the leakage current, which for new devices is 1 mA (as defined in the EN 61643-11 standard), increases over time, causing the varistor to overheat, which in turn may lead to a short circuit of its structure. The environmental conditions in which the surge protecting devices was installed (temperature, humidity, etc.) and the number of overvoltages correctly conducted to earth are also important for the life of surge protecting device.

The surge protecting device is subject to breakdown (discharges the surge impulse to ground) when the surge exceeds its maximum operating voltage. The test allows user to determine whether this is done correctly. The meter applies increasingly higher voltage to the surge protecting device with a specific voltage increase ratio, checking the value for which breakdown will occur.

The measurement is made with DC voltage. Since the surge arrester operate on AC voltage, the result is converted from DC voltage to AC voltage according to the following formula:

$$U_{AC} = \frac{U_{DC}}{1.15\sqrt{2}}$$

A surge protector can be considered faulty when the **U_{AC} breakdown voltage**:

- **exceeds 1000 V** – then there is a break in the arrester and it does not have a protective function,
- **is too high** – then the installation protected by the arrester is not fully protected, as smaller overvoltage surges may penetrate it,
- **is too low** – this means that the arrester may discharge to the ground signals close to the rated voltage to ground.

Before the test:

- check the safe voltages for the tested limiter. Make sure you don't damage it with the test parameters you set. In case of difficulties, follow the EN 61643-11 standard,
- disconnect the limiter from the voltage – disconnect the voltage wires from it or remove the insert that will be tested.

To take a measurement, you must set ( ):

- **U_n** measurement voltage – maximum voltage that can be applied to the limiter. The voltage increase ratio also depends on its selection (1000 V: 200 V/s, 2500 V: 500 V/s),
- **U_C AC (max)** voltage limit – parameter given on the housing of the tested limiter. This is the maximum voltage at which breakdown should not occur,
- **U_C AC tol.** [%] tolerance range for the actual breakdown voltage. It defines the range of U_{AC} MIN…U_{AC} MAX, in which the actual voltage of the limiter should be included, where:

$$U_{AC}\ MIN = (100\% - U_C\ AC\ tol)\ U_C\ AC\ (max)$$
$$U_{AC}\ MAX = (100\% + U_C\ AC\ tol)\ U_C\ AC\ (max)$$

  The tolerance value should be obtained from materials provided by the limiter manufacturer, e.g. from the catalogue card. The EN 61643-11 standard allows a maximum of 20% tolerance.

1

- Select **SPD** measurement.
- Enter the measurement settings (**sec. 2.2**).

2

Connect test leads:

- **+** to the surge protector's phase terminal,
- **-** to the surge protector's earthing terminal.

3

5 s

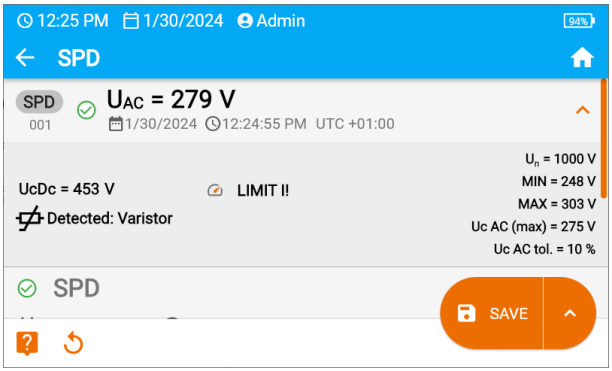
Press and hold **START** button for **5 seconds.** This will trigger a 5-second count-down, after which the measurement will **start**.

Quick start (without a delay of 5 seconds) perform by sliding the **START** button.

The test will continue **until the breakdown of the protector occurs** or until ■ is pressed.

4

After the measurement is completed, you can read the result. Touching the bar with the result will now also reveal partial results.



U_{AC} – AC voltage at which the protector breakdown occurred
U_{AC} – DC voltage at which the protector breakdown occurred
Detected:… - protector type identified

U_n – maximum DC measuring voltage
MIN = U_{AC} MIN – lower limit of the range in which the U_{AC} voltage should be included
MAX = U_{AC} MAX – upper limit of the range in which the U_{AC} voltage should be included
U_C AC (max) – maximum operating voltage value given on the protector
U_C AC tol. – tolerance range for the actual breakdown voltage of the protector

5 You may do the following with the measurement result:

ignore and exit to the measurement menu,

repeat it (the selection window for the measurement you want to repeat will be shown),

SAVE – save to memory,

▶ 

SAVE AND ADD – create a new folder/device which is equivalent to the folder/device where the result of the previously performed measurement was saved,

▶ 

SAVE TO THE PREVIOUS ONE – save the result in the folder/device where the result of the previously performed measurement was saved.

5.9 SV – measurements with a voltage increasing in steps

Measurement with step voltage (SV) indicates that regardless of the value of the test voltage, an object with good resistance properties should not significantly change its resistance. In this mode the meter performs a series of 5 measurements with step voltage; the voltage change depends on the set maximum voltage:

- **250 V**: 50 V, 100 V, 150 V, 200 V, 250 V,
- **500 V**: 100 V, 200 V, 300 V, 400 V, 500 V,
- **1 kV**: 200 V, 400 V, 600 V, 800 V, 1000 V,
- **2.5 kV**: 500 V, 1 kV, 1.5 kV, 2 kV, 2.5 kV,
- **Custom**: you can enter any maximum voltage U_{MAX}, which will be reached in steps of $^1/_5$ U_{MAX}. For example **700 V:** 140 V, 280 V, 420 V, 560 V, 700 V.

Available voltages depend on the hardware platform.

To perform a measurement, first set ( ):

- maximum (final) measurement voltage $\mathbf{U_n}$,
- total duration of the measurement **t**.

The end result for each of the five measurements is saved, which is signalled by a beep.

1

- Select **SV** measurement.
- Enter the measurement settings (**sec. 2.2**).

2

Connect test leads according to **sec. 3.1.2**.

3

Press and hold **START** button for **5 seconds.** This will trigger a 5-second count-down, after which the measurement will **start**.

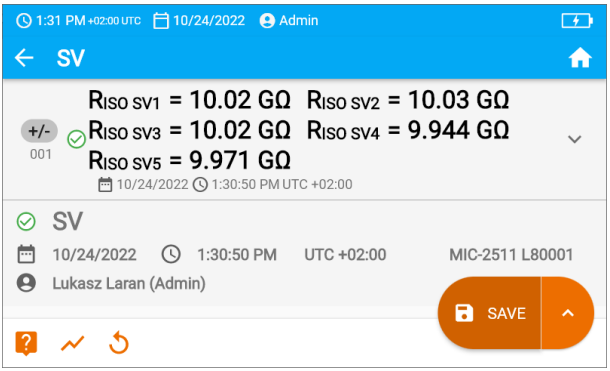
Quick start (without a delay of 5 seconds) perform by sliding the **START** button.

Testing will continue **until it reaches the preset time** or until is pressed.

Touching the bar with the result reveals partial results.

During the measurement, it is possible to display the graph (**sec. 6.1**).

4 After the measurement is completed, you can read the result. Touching the bar with the result will now also reveal partial results.



You can now also display the graph (**sec. 6.1**).

5 You may do the following with the measurement result:

ignore and exit to the measurement menu,

repeat it (the selection window for the measurement you want to repeat will be shown),

SAVE – save to memory,

SAVE AND ADD – create a new folder/device which is equivalent to the folder/device where the result of the previously performed measurement was saved,

SAVE TO THE PREVIOUS ONE – save the result in the folder/device where the result of the previously performed measurement was saved.

- Disabling t_2 time will also disable t_3.
- The timer measuring the measurement time is started when U_{ISO} voltage is stabilized.
- **LIMIT I** informs of an operation with limited inverter power. If this condition persists for 20 seconds, the measurement is stopped.
- If the meter is unable to charge the capacitance of the tested object, **LIMIT I** is displayed and after 20 s **the measurement is stopped**.
- A short tone informs for every period of 5 seconds of time that has lapsed. When the timer reaches characteristic points (t_1, t_2, t_3 times), then for 1 second, an icon of this point is displayed which is accompanied by a long beep.
- If the value of any of the measured partial resistance is out of range, then the value of the absorption coefficient is not shown and horizontal dashes are displayed.
- After completion of the measurement, the capacitance of the tested object is discharged by shorting **R_{ISO}+** and **R_{ISO}-** terminals with resistance of ca. 100 kΩ. At the same time, the message **DISCHARGING** is displayed, as well as the value of U_{ISO} voltage that is present at that time on the object. U_{ISO} decreases over time until it is fully discharged.

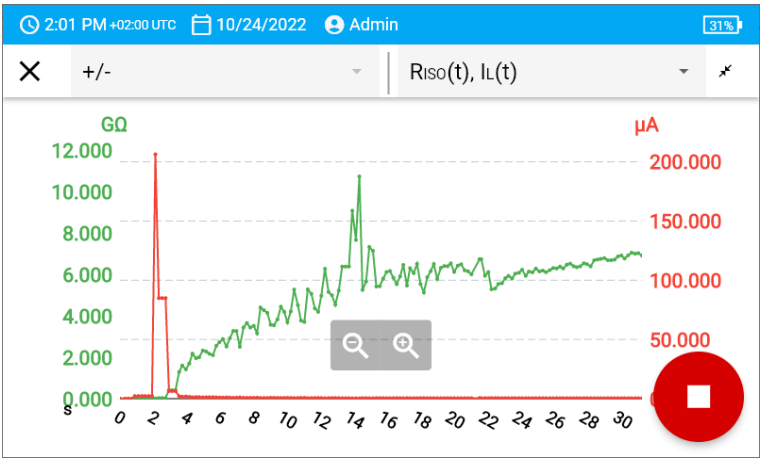
6 Special features

6.1 R_{ISO} graphs

1a

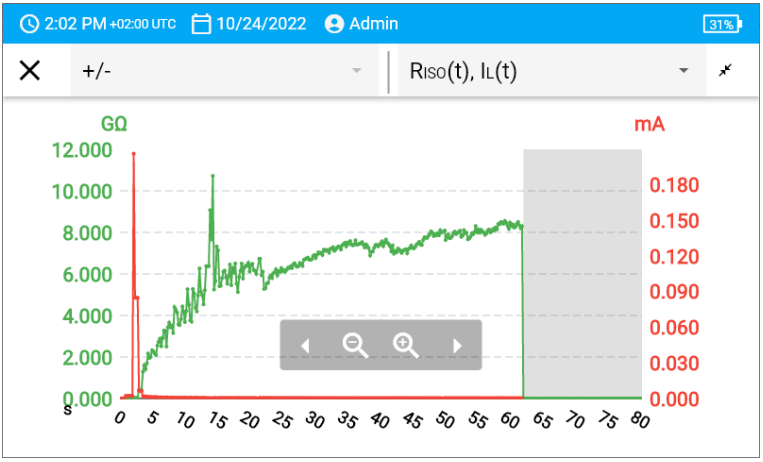
Gdy During the R_{ISO} measurement, it is possible to display the graph. Using the options on the top bar, you can display:

- a graph for the required pair of wires,
- the data set to be presented.



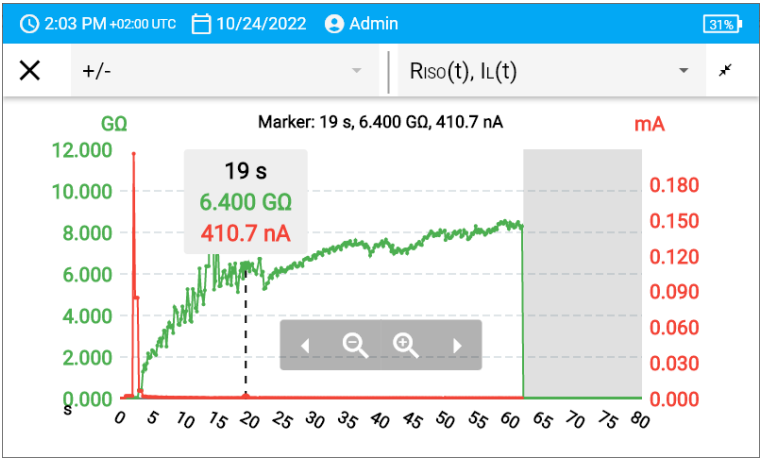
1b

You can also open the graph after the measurement is finished.



2

W During or after the measurement, you can display or hide the sub-result for a given second of the test. To do this, simply touch the point on the graph that interests you.



Description of function icons

+/- **L1/L2** user	Marking the measured pair of conductors. If a measurement is in progress, only the currently measured pair is available
	Switching to the shortened graph (last 5 seconds of the measurement)
	Fitting the entire graph on the screen
	Scrolling the graph horizontally
	Extending the graph horizontally
	Narrowing the graph horizontally
	Return to the measurement screen

6.2 Correcting the R_{ISO} value to the reference temperature

The meter has the ability to convert the R_{ISO} measurement value to resistance values at reference temperatures acc. to the ANSI/NETA ATS-2009 standard. To obtain these results, the user has to:

- enter the temperature value manually or
- connect the temperature probe to the instrument.

The following options are available:

- R_{ISO} converted to a value at 20ºC for oil insulation ((applies i.e. to insulation in cables),
- R_{ISO} converted to a value at 20ºC for solid insulation (applies i.e. to insulation in cables),
- R_{ISO} converted to a value at 40ºC for oil insulation (applies i.e. to insulation in rotating machinery),
- R_{ISO} converted to a value at 40ºC for solid insulation (applies i.e. to insulation in rotating machinery).

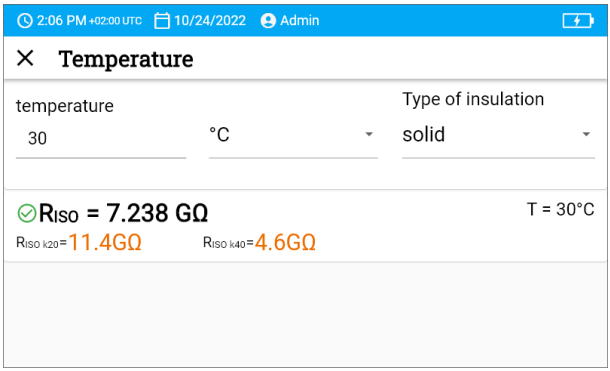
6.2.1 Correction without the temperature probe

1 Perform the measurement.

2 Save the result in the memory

3 Go to this result in the memory of the meter.

4 Enter the temperature of the tested object and the type of its insulation. Then the meter will convert the measured resistance into the resistance at the reference temperature: 20°C ($R_{ISO\ k20}$) and 40°C ($R_{ISO\ k40}$).



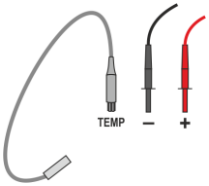
To obtain a temperature reading, you can also connect a temperature probe to the meter and enter its reading. See **sec. 6.2.2, step 1**.

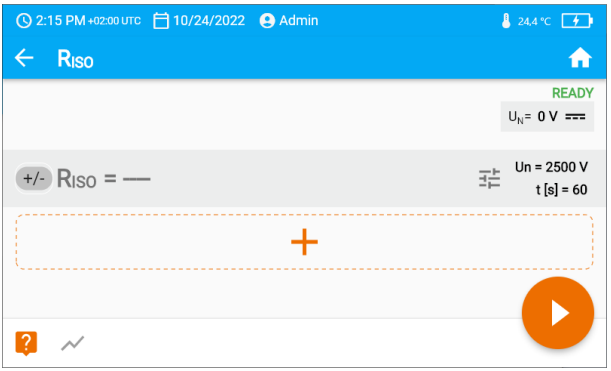
6.2.2 Correction with the temperature probe

WARNING

To ensure user safety, it is not allowed to mount the temperature probe on objects with voltage higher than 50 V to earth. It is advisable to ground the examined object before mounting the probe.

1 Connect the temperature probe to the meter. The temperature measured by the instrument is displayed at the top of the screen.





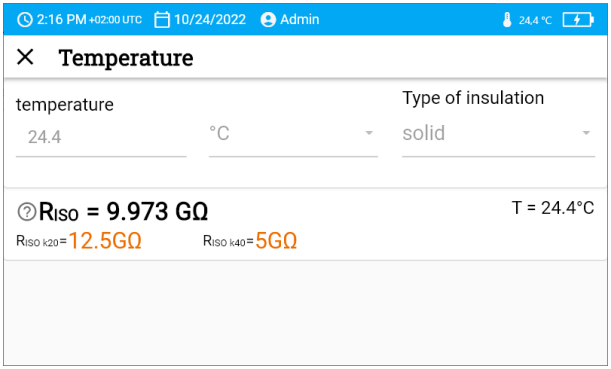
2 Perform the measurement.

3 Save the result in the memory

4 Go to this result in the memory of the meter.

5

Enter the type of insulation of the tested object; the temperature at which the measurement was performed will be stored in the memory and cannot be changed. The meter will convert the measured resistance into the resistance at the reference temperature: 20°C ($R_{ISO\ k20}$) and 40°C ($R_{ISO\ k40}$).



You will change the temperature unit by following **sec. 1.5.4**.

7 Memory of the meter

7.1 Memory structure and management

The memory of measurement results is in a tree structure. It consists of parent folders (maximum 100) in which child objects are nested (maximum 100). The number of these objects is unlimited. Each of them has sub-objects. The maximum total number of measurements is 9999.

Viewing and managing the memory structure is very simple and intuitive – see the tree below.

Add new:

- folder
- instrument
- measurement (and go to the measurement menu to select and take a measurement)

Enter the object and:

- show options
- show object details
- edit details of the object (enter/edit its characteristics)

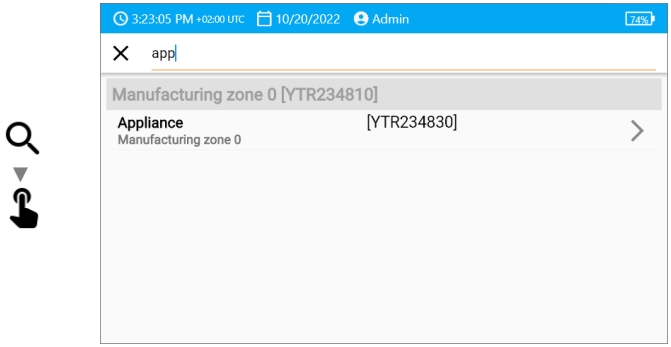
Select the object and:

- select all objects
- delete selected objects

- In the memory menu you can see how many folders ( ) and measurement results ( ) are present in a given object.
- When the number of results in the memory reaches the maximum, saving the next one is only possible provided by overwriting the oldest result. In this situation, the meter will display an appropriate warning before saving.

7.2 Search function

To find the desired folder or object faster, use the search function. After selecting icon , simply enter the name of what you are looking for and tap on the appropriate result to proceed.



7.3 Saving measurement result data to the memory

You can save measurements in two ways:

- by performing a measurement and then assigning it to an object in the memory structure ( ),
- by entering an object in the memory structure and making a measurement from this level (►).

However, you won't save them directly to parent folders. You will need to create a child folder for them.

7.3.1 From the measurement result to the object in memory

1 End the measurement or wait for it to be completed.

2 Save the result in the memory (**SAVE**).

► Create a new folder/device which is equivalent to the folder/device where the result of the previously performed measurement was saved (**SAVE AND ADD**).

► Save the result in the folder/device where the result of the previously performed measurement was saved (**SAVE TO THE PREVIOUS ONE**).

3 If you have selected the **SAVE** option, the window for selecting the save location selection window will open. Select the right one and save the result in it.

7.3.2 From the object in memory to the measurement result

1 In the meter's memory, go to the location where the results are to be saved.

2 Select the measurement you want to perform

3 Perform the measurement.

4 Save the result in the memory.

8 Troubleshooting

Before sending the instrument for repairs, contact our service department. It maybe possible that the meter is not damaged, and the problem has been caused by some other reasons.

The meter can only be repaired at outlets authorized by the manufacturer.

Troubleshooting of typical problems during the use of the meter is described in the table below.

Symptom	Action
There are problems with saving or reading measurements.	Optimize the meter's memory (**sec. 1.5.6**).
There are problems navigating through folders.	
Repairing the meter's memory did not bring the expected results.	Reset the meter's memory (**sec. 1.5.6**).
There are problems preventing the use of memory.	
Operation of the meter is noticeably slower: long response to touching the screen, delays when navigating through the menu, long saving to memory, etc.	Reset the meter to the factory settings (**sec. 1.5.6**).
FATAL ERROR message and error code.	Contact the customer service centre and provide the error code to get help.
The meter does not respond to user actions.	Press and hold the ⏻ button for ca. 7 seconds to turn off the meter.

9 Additional information displayed by the meter

9.1 Electrical safety

	Obecność napięcia pomiarowego na zaciskach miernika.
 **NOISE**	Interference voltage lower than 50 V DC or 1500 V AC is present on the tested object. Measurement is possible but may be burdened with additional error.
 **LIMIT I**	Activation of current limit. The symbol displayed is accompanied by a continuous beep.
 **HILE**	Breakdown of the tested object insulation, the measurement is interrupted. The message appears after **LIMIT I** displaying for 20 s during the measurement, when the voltage previously reached the nominal value.
 **UDET** **U_N>50 V**	Dangerous voltage on the object. The measurement will not be performed. In addition to the displayed information: • U_N voltage value at the object is displayed, • a two-tone beep is generated, • red LED flashes.
 **DISCHARGING**	Discharging the object in progress.

10 Manufacturer

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

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