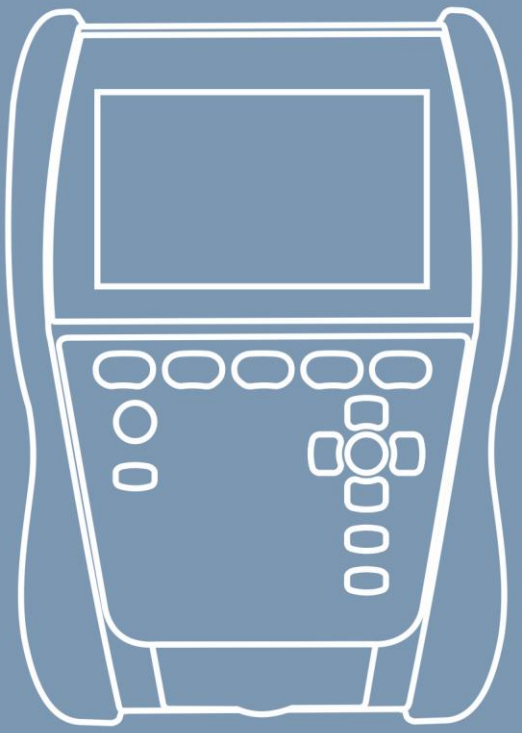


User manual

MIC-2511

Insulation resistance meter


AutoISO
R_{ISO}– / R_X– / R_{CONT}–
R_{ISO}G
R_{ISO}+ / R_X+ / R_{CONT}+
F1
F2
F3
F4
F5
USB-PD

User manual

MIC-2511

Insulation resistance meter

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

Version 2.00 15.04.2024

The MIC-2511 meter is a modern, top quality measuring instrument which is easy and safe to use, provided that the principles presented in this manual are observed.

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. You can find a detailed description of the system in the dedicated user manual.

The manual can be found on the manufacturer's website. Check **www.sonel.com › EN › Download › User manuals** (**Software** section) and the instrument page (**Files** section).

CONTENTS

1 General information

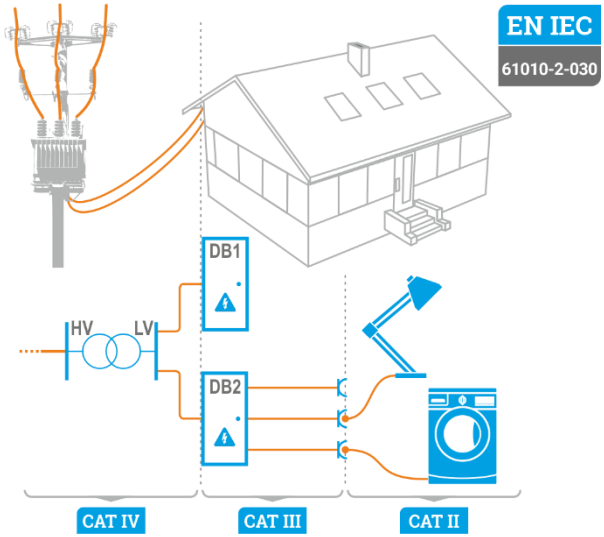
1.1 Safety symbols

The following international symbols are used in the device and/or in this manual:

	Refer to the user manual for additional information and explanations		Ground		AC current/voltage
	DC current/voltage		Double insulation (protection class)	CE	Declaration of Conformity with EU directives (*Conformité Européenne*)
	Do not dispose of with other household waste	2500 V	Attention, risk of electric shock. The device generates a voltage of 2500 V	>1500 V	Do not connect the device to systems with voltages above 1500 V

Measurement categories according to EN IEC 61010-2-030:

- **CAT II** – concerns measurements performed in circuits directly connected to low voltage installations,
- **CAT III** – concerns measurements performed in buildings installations,
- **CAT IV** – concerns measurements performed at the source of low voltage installation.



1.2 Behaviour of signalling LEDs

The LED is on continuously

The LED flashes slowly

The LED flashes rapidly

1.3 Safety

To avoid electric shock or fire, as well as provide the conditions for correct operation and accuracy of obtained results, you must observe the following guidelines:

- Before you proceed to operate the device, acquaint yourself thoroughly with this manual and observe the safety regulations and specifications defined by the producer.
- Any application that differs from those specified in this manual may result in damage to the device and constitute a source of danger for the user and bystanders.
- The device must be operated solely by appropriately qualified personnel with relevant certificates to realise measurements of electric installation. Operating the analyzer by unauthorised personnel may result in damage to the device and constitute a source of danger for 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 with the person responsible for health and safety.
- Before starting the work, check the device, wires, adapters and other accessories for any sign of mechanical damage. Pay special attention to the connectors.
- It is unacceptable to operate:
  - ⇒ it is damaged and completely or partially out of order,
  - ⇒ its cords and cables have damaged insulation,
  - ⇒ of the device and accessories mechanically damaged,
  - ⇒ it was stored for an excessive period of time in disadvantageous conditions (e.g. excessive humidity) After moving the device from a cool to a warm place with a high level of relative humidity, do not start measurements until the device is warmed up to the ambient temperature (approximately 30 minutes).
- Before measurement, choose a correct measurement function and make sure that the test leads are connected to their respective measuring terminals.
- The correct operation of the instrument and accessories must be checked regularly to avoid any hazard which may result from erroneous results.
- In a situation where the product works with other instruments or accessories, the lowest measurement category of the connected devices is used.
- Do not power the meter from sources other than those listed in this manual.
- Repairs may only be performed by an authorised service point.

WARNING

- **Only accessories for a given device should be used. Using other accessories may cause damage to measuring terminals, introduce additional measurement error and create a risk for the user.**
- **Before the measurement of insulation resistance you must be sure that the test object is disconnected from the power supply.**
- **During measurements of insulation resistance, dangerous voltage up to 2.75 kV**
- **(2.5 kV + (0…10%)) occurs at the ends of test leads of the meter.**
- **During the measurement of insulation resistance do not disconnect test leads from the test object before the measurement is completed. Otherwise the capacitance of the object will not be discharged, creating the risk of electric shock.**
- **When measuring the resistance of a cable, ensure that the other end of the cable is protected against accidental contact.**
- **Do not touch the tested object during the R_{ISO} insulation resistance measurement or after the measurement before it is fully discharged. It may result in electric shock.**

- The R_{ISO} inputs of the meter are protected electronically from overload (e.g. due to having been connected to a live circuit) up to 1500 V for 60 seconds.
- Due to continuous development of the meter's software, the actual appearance of the display for some features may slightly differ from that presented in this user manual. The latest version of the manual is provided on the manufacturer's website.

2 Quick start

When you start the device for the first time, you must set the interface language and create a user account. Finally, set the date, time and time zone.

1		Turn the meter on.
2		Create or log in to a user account.
3		Enter the meter settings
4		Select measurement. You can find information about it under icon.
5		Enter the measurement settings.
6		Connect the meter to the tested object.
7	5 s	Start the measurement.
	+	Quick start, without a delay of 5 seconds – perform it by pressing **ENTER** and also pressing hold of the **START** button.
8	/	End the measurement or wait for it to be completed. Then you can enter additional information about the measurement.
9		Save the result in the memory.
10	3 s	Turn the meter off.

- The menu windows are available under the function buttons..
  - ⇒ **F1** – Help.
  - ⇒ **F2** – Main settings.
  - ⇒ **F3** – Measurements.
  - ⇒ **F4** – Memory.
- You can save measurements in two ways:
  - ⇒ by performing a measurement and then assigning it to an object in the memory structure,
  - ⇒ entering an object in the memory structure and making a measurement at this memory location.

3 Interface

The physical buttons are used to navigate the menu – just like the touch interface controls. They are necessary for when you turn off the screen touch function.

▲

F1	Help		Up
F2	Main Settings		Down
F3	Measurements		Left
F4	Memory		Right
F5	Recently used views		Confirm
	• Turn on the meter / display brightness (short press) • Turn off the meter (press and hold)		Back / delete sign / stop measurement
	Start / stop measurement		Go to the main window

To activate a given interface element, use the arrows to select it (successive selected elements will be highlighted), and then press the button to confirm your selection. The same principle applies to the entire interface: from measurement screens, through the memory management menu and to the help.

4 Measurements

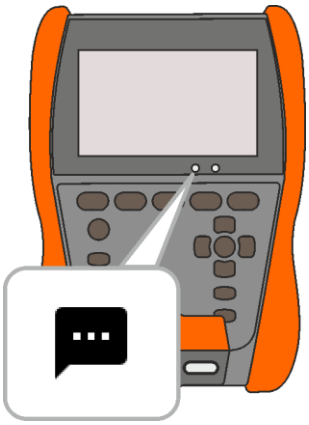
WARNING

- **The tested object must not be under voltage higher than 50 V.**
- **<u>Take particular care during cable measurement.</u> The risk of electric shock is present also after discharging their capacitance by the meter, as the voltage can be rebuilt automatically.**
- **During measurements, it is recommended to use electrical insulating personal protection equipment, which reduces the risk of touching the wires that may pose a threat to the user.**
- **During measurements of insulation resistance, dangerous voltage up to 2.5 kV + (0…10%) occurs at the ends of test leads of the meter.**
- **It is forbidden to disconnect test leads before the measurement is completed. Failure to obey the above instruction will lead to high voltage electric shock and make it impossible to discharge the tested object.**
- **<u>Take particular care during cable measurement.</u> After discharging their capacitance by the meter the voltage can be rebuilt automatically.**

NOTE!
Connecting voltage higher than 1500 V between any of the test terminals may damage the meter.

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.

4.1 Measurement indicators



Before the measurement

The voltage on the object is present continuously and does not exceed 50 V. The measurement is possible, but it may be burdened with an additional error.

- The voltage on the object is present continuously and exceeds 50 V. The measurement is blocked.
- Emergency state of the meter.

During the measurement

R_{ISO}	R_X
The meter is measuring the insulation resistance.	Continuity is maintained.
The meter has finished measuring the insulation resistance and is currently discharging the tested object.	
3x The measurement is completed and the tested object is discharged.	

5 Data transmission

5.1 Set of accessories to connect the meter to a PC

In order to ensure the communication of the meter with a computer a USB cable and the relevant software are required:

- Sonel Reader,
- Sonel Reports PLUS.

The software may be used for many devices manufactured by SONEL S.A. which are equipped with a USB interface. Detailed information is available from the manufacturer and distributors.

If the required software has not been purchased with the meter, it may be obtained from the manufacturer or from an authorised distributor.

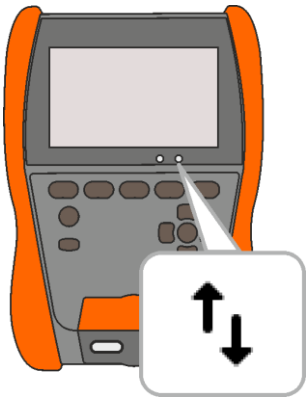
5.2 Data transmission through USB port

1 Enter the USB mode on the meter.

2 Use the USB cable to connect the meter to the computer.

3 Start the software for data transfer. During data transmission, all buttons on the meter are locked, except for those responsible for interrupting the transmission and switching off the device.

Additional information displayed by the meter



USB communication, data transfer.

6 Software update

1 Download the update file from the manufacturer's website.

2 Save the update file to a USB stick. The stick must be formatted as a FAT32 file system.

3 **3 s** Turn the meter off.

4 Insert the USB stick into the right port of the meter.

5 + Press and hold down button to turn on the meter. Release only when the message on starting the update appears.

6 Watch the update progress. Wait until it's finished. You will be informed about the update result with an appropriate message.

- Before starting the update, charge the meter battery to 100%.
- The update will start if the software version on the USB stick is newer than the version currently installed on the meter.
- Do not turn off the meter while the update is in progress.
- During the update, the meter may turn off and on automatically.

7 Power supply

NOTE!

- Before operating the meter, discharge the battery and then fully charge it, so that the indication of its charged status is correct.
- In order to do this as quickly as possible, proceed as follows:
  - ⇒ set the maximum brightness of the display,
  - ⇒ enter the measurement of insulation resistance,
  - ⇒ set the maximum measurement voltage and the maximum measurement time,
  - ⇒ start the measurement,
  - ⇒ after discharging and the meter automatically switching off, proceed to charging the battery.

The charge level of the rechargeable battery is indicated by the symbol in the right upper corner of the display on a permanent basis.

Battery charged.

Battery completely discharged – charge it. All measurements are blocked. The meter will turn off automatically when the battery charge drops to a critical level.

Charging of the battery is in progress.

Battery failure. It is recommended to replace it with a new one.

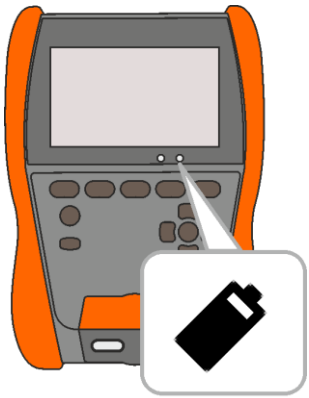
Charging voltage too high. Change the charger or power supply source.

Battery temperature out of permissible range. If a charging is in progress, it will be aborted.

No battery. The meter operates on an external power supply.

Battery status unknown. Contact the customer service centre.

Additional information displayed by the meter



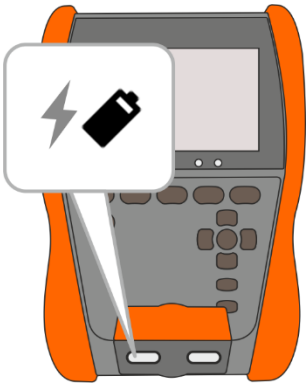
Low battery charge level.

Battery problem

Charging of the battery is in progress.

7.1 Battery power

The meter is powered by a lithium-ion battery. The meter is charged by a USB power supply. It can be also charged from the car 12 V accessory socket, using an optional converter.



NOTE!

Do not power the meter from sources other than those listed in this manual.

7.2 Charging rechargeable battery

Charging starts once the power supply has been connected to the meter, regardless of whether the meter is on or off. The charging status is indicated on the display and by an active LED.

The charging algorithm allows the battery to be charged to approx. 90% in less than 2 hours. Charging time may take longer in non-optimal environmental conditions (too high or too low temperature) or in the case of using a USB-C-PD power adapter with parameters other than the factory supplied adapter (USB-C-PD 20 V min. 2.25 A).

Charging by any of the following methods is only possible with the meter turned off and will take more than 16 hours:

- power bank,
- power supply that does not support the USB-C-PD standard,
- computer USB port,
- via the USB-A / USB-C adapter.

If the battery temperature is below 0°C or above 45°C then charging stops completely.

When the meter is turned off by button or by AUTO-OFF, the charging process is not stopped.

Indication of completed charging is shown by: 100%.

7.3 Power supply from mains

It is possible to charge the battery when carrying out the measurements. To do this, just connect the factory supplied charger to the meter.

When the meter is turned off by button or by **AUTO-OFF**, the charging process is not stopped.

7.4 General rules for using Li-Ion rechargeable batteries

- Store the meter with batteries charged at least to 50%. 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. The environment should be dry and well ventilated. Protect the device from direct sunlight.
- Charge the batteries in a cool, well-ventilated place at a temperature of 10°C ... 28°C. Modern fast chargers detect both too low and too high temperature of rechargeable batteries and react to the situation adequately. When the temperature is too low, charging is prevented as it may irreparably damage the batteries.
- 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 of the battery pack into fire.
- Li-Ion cells are sensitive to mechanical damage. This kind of damage may cause its permanent damage and thus cause ignition or explosion. Any interference in the structure of Li-ion battery pack may cause its damage. This may result in its 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 comes into contact with eyes or skin, immediately rinse the affected area with plenty of water and consult with 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 its ignition. The seller and the manufacturer shall not be liable for any damages resulting from improper handling of the Li-Ion battery pack.

8 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 might damage the casing (powders, pastes, etc.).

Clean the probe with water and dry it.

The test leads should be cleaned with water and detergents, and then dried.

The electronic system of the meter does not require maintenance.

9 Storage

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

- disconnect all the test leads from the meter,
- clean the meter and all its accessories thoroughly,
- wind the test leads,
- in order to prevent a total discharge of the battery pack in the case of a prolonged storage, charge the device **at least once every six months**.

10 Dismantling and utilisation

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

Worn-out electronic equipment should be sent to a collection point in accordance with the regulations valid in a given region.

Before the equipment is sent to a collection point, do not dismantle any elements.

Observe local regulations concerning disposal of packages, waste batteries and rechargeable batteries.

11 Technical data

11.1 Basic data

⇒ The abbreviation "m.v." used in the specification of accuracy denotes a measured value

11.1.1 Measurement of AC/DC voltage

Measurement range: 0 V…1500 V

Display range	Resolution	Accuracy
0 V...1500 V	1 V	±(3% m.v. + 2 digits)

- Frequency range: 45…65 Hz

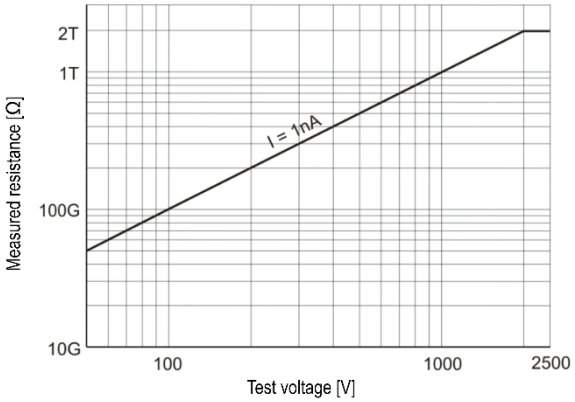
11.1.2 Measurement of insulation resistance

- Accuracy of generated voltage (R_{LOAD} [Ω] ≥ 1000*U_n [V]): 0…+5% or 0…+10% from the set value
- Measurement range acc. to EN IEC 61557-2: **10 kΩ …2.000 TΩ** (I_{ISOnom} = 2 mA +(−0.8…0)mA)
- Maximum short-circuit current I_{sc}: ≤2 mA

Two-lead measurement

Approximate maximum values of the measured resistance, depending on the test voltage, are presented in the table below. For other voltages the range limits may be read from the chart below.

Voltage	Measurement range
10 V	10 GΩ
25 V	20 GΩ
50 V	50 GΩ
100 V	100 GΩ
250 V	250 GΩ
500 V	500 GΩ
1000 V	1.00 TΩ
2500 V	2.00 TΩ



Display range	Resolution	Accuracy
0.0…999.9 kΩ	0.1 kΩ	±(3% m.v. + 20 digits)
1.000…9.999 MΩ	0.001 MΩ	
10.00…99.99 MΩ	0.01 MΩ	
100.0…999.9 MΩ	0.1 MΩ	
1.000…9.999 GΩ	0.001 GΩ	
10.00…99.99 GΩ	0.01 GΩ	
100.0…999.9 GΩ	0.1 GΩ	
1.000…2.000 TΩ	0.001 TΩ	

Three-lead measurement

Additional error in the three-lead method (effect of G terminal): 0.05% in eliminating the leakage caused by resistance of 250 kΩ during measurement of 100 MΩ with test voltage of 50 V.

Measurement with AutoISO-2511

Approximate maximum values of the measured resistance, depending on the test voltage, are presented in the table below.

Voltage	Measurement range
10 V	10 GΩ
25 V	20 GΩ
50 V	50 GΩ
100 V	100 GΩ
250 V	250 GΩ
500 V 1000 V 2500 V	400 GΩ

Display range	Resolution	Accuracy
0.0…999.9 kΩ	0.1 kΩ	±(4% m.v. + 20 digits)
1.000…9.999 MΩ	0.001 MΩ	
10.00…99.99 MΩ	0.01 MΩ	
100.0…999.9 MΩ	0.1 MΩ	
1.000…9.999 GΩ	0.001 GΩ	
10.00…99.99 GΩ	0.01 GΩ	
100.0…400.0 GΩ	0.1 GΩ	±(8% m.v. + 20 digits)

For insulation resistance below R_{ISOmin} there is no accuracy specified because the meter works with the adjustable current limit in accordance with the following formula:

$$R_{ISO\,min} = \frac{U_{ISO\,nom}}{I_{ISOnom}}$$

where:
R_{ISOmin} – minimum insulation resistance measured without limiting the converter current
U_{ISOnom} – nominal test voltage
I_{ISOnom} – nominal converter current (1.6 mA)

11.1.3 Measurement of capacitance

Display range	Resolution	Accuracy
0 nF…999 nF	1 nF	±(5% m.v. + 5 digits)
1,00 µF…9,99 µF	0,01 µF	

- Measurement of capacitance is available only during R_{ISO} measurement (when discharging the object).
- Accuracy of measurement is met for the tested capacitance connected in parallel with a resistance greater than 10 MΩ.
- For measurement voltages below 100 V the measurement error is not specified.
- Charging time of C=1 µF capacitance up to 2500 V: 1.4 s.
- Discharge time of C=1 µF capacitance: 35 s.

11.1.4 Low-voltage measurement of continuity and resistance

Measurement of continuity of protective conductors and equipotential bondings with ±200 mA current

Measuring range according to EN IEC 61557-4: 0.10…999 Ω

Display range	Resolution	Accuracy
0.00…19.99 Ω	0.01 Ω	±(2% m.v. + 3 digits)
20.0…199.9 Ω	0.1 Ω	
200…999 Ω	1 Ω	±(4% m.v. + 3 digits)

- Voltage at open terminals: 8…16 V
- Output current at R < 2 Ω: I_{SC} > 200 mA
- Compensation of test leads resistance
- Measurements for both current polarizations

Measurement of resistance with low current

Display range	Resolution	Accuracy
0.0…199.9 Ω	0.1 Ω	±(2% m.v. + 3 digits)
200…999 Ω	1 Ω	±(4% m.v. + 4 digits)

- Voltage at open terminals: 8…16 V
- Output current >10 mA
- Audio signal for measured resistance of <10 Ω ± 10%
- Compensation of test leads resistance

11.1.5 Measurement of temperature

Display range	Resolution	Accuracy
-40.0…99.9°C	0.1°C	±(3% m.v. + 8 digits)
-40.0…211.8°F	0.1°F	±(3% m.v. + 16 digits)

- Measurement using an external probe

11.1.6 Measurement of resistance in EPA zones

Display range for U_n = 10 V	Resolution	Accuracy
0.0…999.9 kΩ	0.1 kΩ	±(8% m.v. + 20 digits)
1.0…9.999 MΩ	0.001 MΩ	
10.00…99.99 MΩ	0.01 MΩ	
100.0…999.9 MΩ	0.1 MΩ	
1.0…10.0 GΩ	0.1 GΩ	

- Test voltage: 10 V ± 5%

Display range for U_n = 100 V	Resolution	Accuracy
0.0…999.9 kΩ	0.1 kΩ	±(3% m.v. + 20 digits)
1.000…9.999 MΩ	0.001 MΩ	
10.00…99.99 MΩ	0.01 MΩ	
100.0…999.9 MΩ	0.1 MΩ	
1.000…9.999 GΩ	0.001 GΩ	
10.00…99.99 GΩ	0.01 GΩ	
100.0…200.0 GΩ	0.1 GΩ	±(8% m.v. + 20 digits)

- Test voltage: 100 V ± 5%

Display range for U_n = 500 V	Resolution	Accuracy
0.0…999.9 kΩ	0.1 kΩ	±(3% m.v. + 20 digits)
1.000…9.999 MΩ	0.001 MΩ	
10.00…99.99 MΩ	0.01 MΩ	
100.0…999.9 MΩ	0.1 MΩ	
1.000…9.999 GΩ	0.001 GΩ	
10.00…99.99 GΩ	0.01 GΩ	
100.0…999.9 GΩ	0.1 GΩ	±(8% m.v. + 20 digits)
1000 GΩ	1 GΩ	

- Test voltage: 500 V ± 5%

11.2 Operating data

a) type of insulation acc. to EN 61010-1 and EN IEC 61557 ..... double
b) measurement category acc. to EN IEC 61010-2-030
   ▪ rated operating altitude ≤2000 m ..... CAT IV 600 V
   ▪ rated operating altitude ≤3000 m ..... CAT III 600 V
c) ingress protection acc. to EN 60529 ..... IP65
d) power supply ..... Li-Ion 10,8 V 3,5 Ah rechargeable battery
e) dimensions ..... 234 x 169 x 70 mm
f) weight ..... ca. 1.3 kg
g) storage temperature ..... -25°C…+70°C
h) operating temperature ..... -20°C…+50°C
i) humidity ..... 20%…90%
j) reference temperature ..... +23°C ± 2°C
k) reference humidity ..... 40%…60%
l) display ..... graphical 5.6" LCD
m) number of R_{ISO} measurements acc. to EN IEC 61557-2 with battery power supply ..... min. 600
n) time of operation on a single battery charge
   ▪ for R_{ISO}=5 MΩ, U_{ISO}=2.5 kV, T=(23±5)°C, screen backlight 50% ..... approx. 3 h
   ▪ under conditions according to EN IEC 61557-2 p. 6.7, screen backlight 50% ..... approx. 7 h
o) memory of measurement results ..... 9999 results
p) transmission of results ..... USB-C
q) quality standard ..... development, design and manufacturing are ISO 9001, ISO 14001, ISO 45001 compliant
r) the device meets the requirements of ..... EN 61010-1, EN IEC 61557, EN IEC 61010-2-030
s) the product meets EMC requirements (immunity for industrial environment) according to the following standards .... EN IEC 61326-1, EN IEC 61326-2-2

NOTE!

The meter is classified in terms of Electromagnetic Compatibility (EMC) as instruments of Class A (for use in industrial environments – according to EN 50011). Interferences, impacting the operation of other devices must be taken into account when the meters are used in other environments (e.g. domestic).

11.3 Additional data

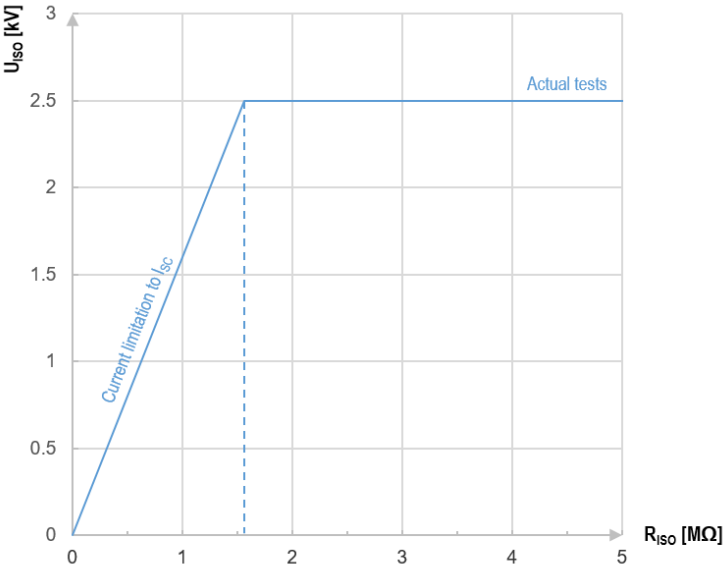
Data on additional uncertainties are useful mainly when the meter is used in non-standard conditions and for metrological laboratories for the purpose of calibration.

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

Significant parameter	Designation	Additional uncertainty
Position	E_1	0%
Supply voltage	E_2	1% (1% not displayed)
Temperature 0°C…35°C	E_3	6%

11.4 Inverter characteristics

Inverter output current $\mathbf{I_{SC}}$ is 2 mA + ⟨–0,8...0⟩ mA. Activation of the current limit is indicated by a continuous beep. The measurement result is correct, but on the test **terminals** the **voltage is lower than the set voltage**. The current limitation occurs in the first phase of the measurement due to charging the capacitance of the tested object.



The actual test voltage U_{ISO} as a function of the measured insulation resistance R_{ISO} (for maximum test voltage)

12 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.

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