Sonel®

OPERATION MANUAL

EARTH RESISTANCE METER

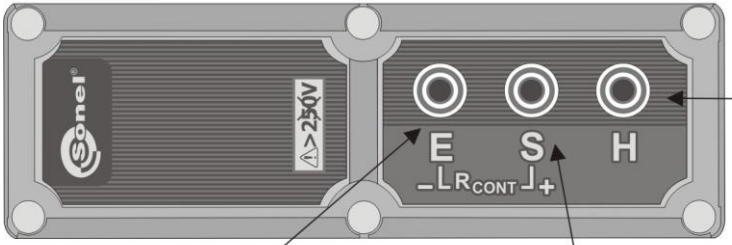
MRU-20

Earth resistance meter MRU-20 is designed to measure earth resistance and the resistance of protective conductors and equipotential bonding.

The most important features of the MRU-20 include:

- earth resistance measurement in double- and three-lead arrangement,
- double-lead earth resistance measurement,
- testing the interference voltage (AC and DC) with the resistance measurement lock function in case of excessive interference,
- testing the electrode resistance to ensure proper accuracy of the measurement,
- resistance measurement of protective conductors and equipotential bonding,
- compensation of test leads resistance (autozeroing),
- large and clear LCD display,
- ergonomic operation,
- power supply: disposable or rechargeable batteries,
- battery charge level indication,
- AUTO-OFF function,
- hermetic enclosure,
- robust and ergonomic measurement accessories along with a case to carry them.

VIEW FROM THE TERMINAL SIDE



H: R_E measurement - current electrode input terminal.

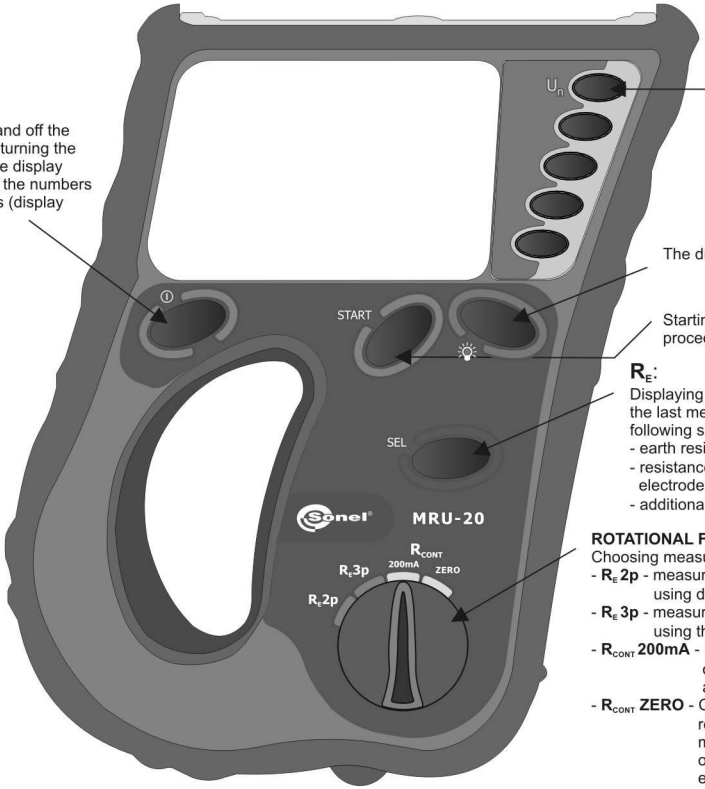
E: R_E measurement: earth measurement input terminal.

R_{CONT} measurement - continuity measurement termina ("-").

S: R_E measurement - voltage electrode input terminal.

R_{CONT} measurement - continuity measurement terminal ("**+**").

MRU-20



Measurement voltage changing: 25V or 50V.

Turning on and off the meter. After turning the meter on, the display will show all the numbers and symbols (display test).

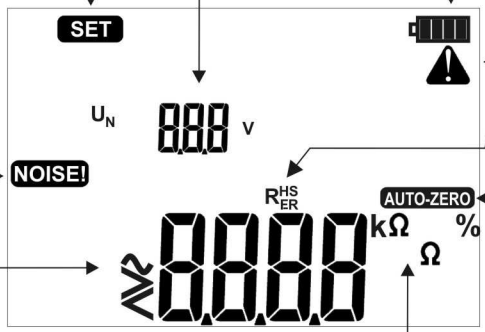
The display backlight on/off.

Starting the measurement procedur.

R_E:
Displaying all velues related to the last measurement - in the following sequence:
- earth resistence R_E,
- resistance of auxiliary electrodes R_H and R_S,
- additional error.

ROTATIONAL FUNCTION SELECTOR
Choosing measurement function:
- **R_E 2p** - measurement of earth resistance using double-pole method,
- **R_E 3p** - measurement of earth resistance using three-pole method,
- **R_{CONT} 200mA** - measurement of the resistance of protective conductors and equipotential bondings,
- **R_{CONT} ZERO** - Compensation of test leads resistance used for the measurement of the resistance of protective conductors and equipotential bondings.

DISPLAY



Parameter configuration mode.

Additional readout field.

Symbol indicating battery charge level.

Highlighting the importance of displayed error information, signaling the need for using the Operating manual.

Signaling the presence of interference voltage with a value enabling the measurement with additional uncertainty.

Symbol of displayed value:
- R - resistance,
- R_E - earth resistance,
- R^H - resistance of **H** electrode,
- R^S - resistance of **S** electrode,
- $_{ER}$ - additional uncertaity caused by resistance of electrodes.

Main display field for measurement result.

Information on completed compensation of test leads resistance.

Unit and type of displayed value:

Ω, kΩ	ohms, kilo-ohms	- resistance
%	percentages	- additional error
V	volts	- interference voltage

OPERATING MANUAL

EARTH RESISTANCE METER
MRU-20

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Version 3.1 24/02/2017

The MRU-20 meter is a modern, easy and safe measuring device. Please acquaint yourself with the present manual in order to avoid measuring errors and prevent possible problems related to operation of the meter.

CONTENTS

1 Safety

MRU-20 meter is designed for measuring parameters important for safety of electrical installations. Therefore in order to provide conditions for correct operation and the correctness of the obtained results, the following recommendations must be observed:

- Before you proceed to operate the meter, acquaint yourself thoroughly with this manual and observe the safety regulations and specifications defined by the producer.
- MRU-20 meter is designed to measure earth resistance and the resistance of protective conductors and equipotential bondings. 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.
- The meter must be operated solely by appropriately qualified personnel members holding required certificates for carrying measurements in electric installations. Unauthorized use of the meter may result in its damage and may seriously endanger unauthorized 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 following:
  - ⇒ a damaged meter which is completely or partially out of order,
  - ⇒ a meter with damaged test leads 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 of a high level of relative humidity, do not carry out measurements until the meter is warmed up to the ambient temperature (approximately 30 minutes).**
- Before commencing measurements, make sure the test leads are connected to the appropriate measurement sockets.
- Do not operate a meter with an open or incorrectly closed battery compartment or power it from sources other 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 276V for 30 seconds.

- Repairs may be carried out only by an authorized service point.
- The device meets the requirements of standards EN 61010-1 and EN 61557-1, -4, -5.

Attention:
The manufacturer reserves the right to introduce changes in appearance, equipment and technical data of the meter.

Note:

An attempt to install drivers in 64-bit Windows 8 may result in displaying "Installation failed" message.

Cause: Windows 8 by default blocks drivers without a digital signature.

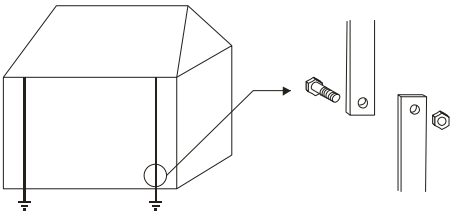
Solution: Disable the driver signature enforcement in Windows.

2 Measurements

2.1 Measurement of resistance using three-pole method

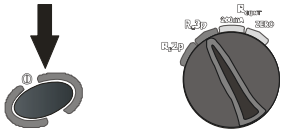
The three-pole measuring method is the basic type of resistance-to-earth measurement.

1



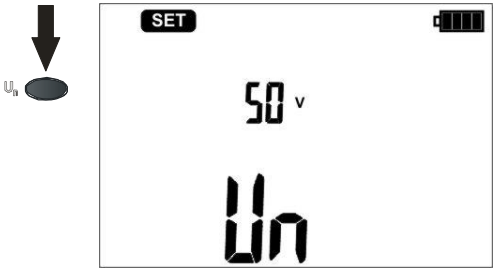
Disconnect earth electrode being tested from the installation of the building.

2



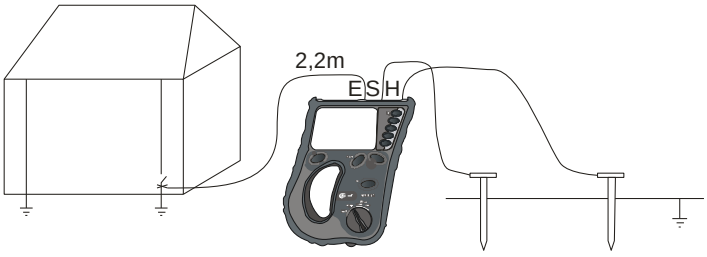
Turn on the meter.
Set the rotational function selector set at **R_E 3p position**.

3



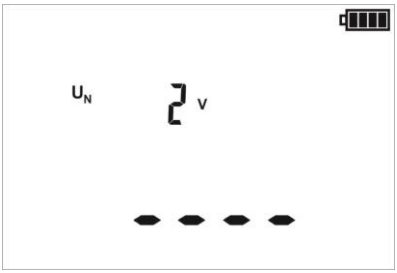
Using **U_n** button set test voltage on 25V or 50V. After 5 sec. the meter returns to the measurement mode. You can also confirm the choice by pressing the **START** push-button.

4



The current electrode (driven into earth) should be connected to **H** socket of the meter.
The voltage electrode (driven into earth) should be connected to **S** socket of the meter.
The earth electrode being tested should be connected to **E** socket of the meter.
The earth electrode being tested and the current electrode and the voltage electrode should be located one line

5

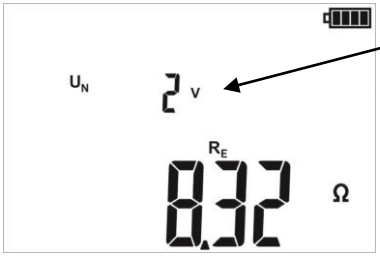


The meter is ready for measurement.
Value of interference voltage is displayed on the auxiliary display

6

Press **START button**.
Carry out the measurement.

7



Value of interference voltage.

Read out main results:

earth electrode resistance R_E.

Auxiliary results may be read after pushing **SEL push-button**.

8

R_H

resistance of current electrode

9

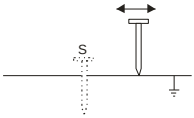
R_S

resistance of voltage electrode

10

Value of additional uncertainty caused by resistance of the electrodes.

(11)



Repeat the measurements (points 3-6) shifting the voltage electrode several meters: the electrode should be shifted farther and closer to the earth electrode being tested. If R_E measurement results differ from each other by more than 3%, the distance of the current electrode from the earth electrode being tested should be considerably increased and the measurements should be repeated

Note:

⚠

Measurement of resistance-to-earth may be carried out if voltage of interferences does not exceed 24 V. Voltage of interferences is measured up to the level of 100 V but above 50 V it is signaled as dangerous The meter must not be connected to voltages exceeding 100 V.

- Particular attention should be paid to quality of connection between the object being tested and the test lead – the contact area must be free from paint, rust, etc.

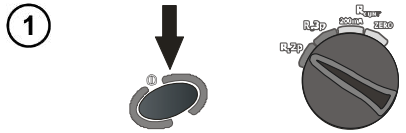
- If resistance of test probes is too high, R_E earth electrode measurement will be burdened with additional uncertainty. Particularly high uncertainty of measurement occurs when a small value of resistance-to-earth is measured with probes that have a weak contact with earth (such a situation occurs frequently when the earth electrode is well made and the upper soil layer is dry and slightly conductive). In such a case, the ratio between resistance of the probes and resistance of the earth electrode tested is very high and consequently, uncertainty of measurement that depends on this ratio is also very high. Then according to guidelines defined in section 7 it is possible to calculate the effect of measurement conditions - or to use the attached chart. This uncertainty is also displayed in [%] as an additional result. It is calculated on the basis of measured valued. If such additional uncertainty exceeds 30% the following symbol is displayed with the measurement result Er. You can improve the contact between the probe and soil, for example, by dampening with water the place where the probe is driven into earth, driving the probe into earth in a different place or using a 80 cm-long probe. Check also the test leads for possible insulation damage and for corroded or loosened connection between the banana plug and the test lead. In majority of cases the measurement accuracy achieved is satisfactory. However, you should always be aware of the uncertainty included in the measurement.

- Calibration performed by the manufacturer takes into account the resistance of supplied measurement lead of 2.2 m

Additional informations displayed by the meter

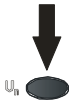
U_x 30 V > 24 V and ⚠	Interference voltage is too high (> 24V) – the measurement is impossible. Turn off the source of interferences or try arrange probes differently
U_x 70 V > 50 V and ⚠ and continuous audio signal 🔊	**Interference voltage is above 50V!** **Immediately** disconnect the meter! Before re-connecting, turn off the source of voltage.
U_x OFL > 50 V and ⚠ and continuous audio signal 🔊	**Interference voltage is above 100V!** **Immediately** disconnect the meter! Before re-connecting, turn off the source of voltage.
-r- with the name of an electrode (or electrodes) and ⚠	Interruption in measuring circuit or resistance of test probes is higher than 60kΩ. Please check connections in the measuring circuit or reduce the resistance of the measuring probe by its repositioning.
Er and the measurement result and ⚠	Uncertainty of R_E measurement introduced by the resistance of test probes exceeds 30%. Reduce the resistance of the probe by its repositioning, or increase the dampness of the ground in the direct vicinity of the probe.
>1,99kΩ	R_E measuring range is exceeded .
>50kΩ	Resistance of test probes is higher than 50kΩ (but lower than 60kΩ).
NOISE!	Interference voltage is above 10V or unstable measurement result or measured voltages or currents are low in relation to noise.
noi 5 and ⚠ and long audio signal 🔊	Measured voltages or currents are too low in relation to noise or very unstable measurement result. (Symbol noi 5 is displayed instead of the result.)
°C and ⚠	Acceptable temperature inside the meter is exceeded.

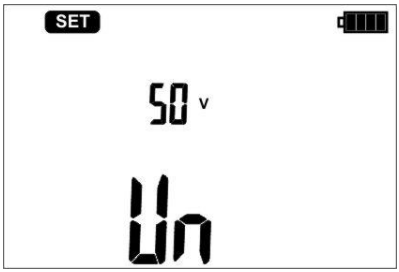
2.2 Measurement of resistance using double-pole method,



Turn on the meter.
Set the rotational function selector at **R_E 2p position**.

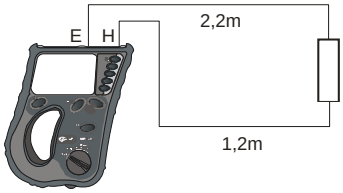
②





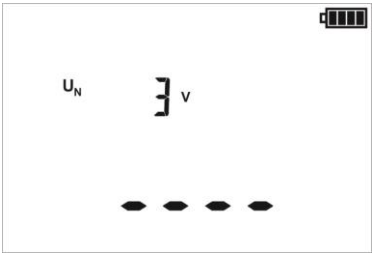
Using**Un** button set test voltage on 25V or 50V. After 5 sec. the meter returns to the measurement mode. You can also confirm the choice by pressing the **START** push-button.

③



Connect the measured object to terminals**E** and **H** of the meter.

④

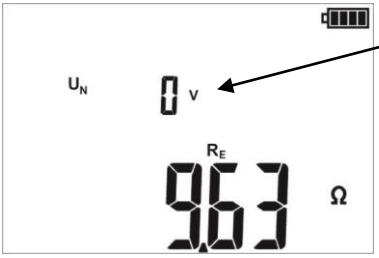


The meter is ready for measurement.
Value of interference voltage is displayed on the auxiliary display.

⑤

Press **START button**.
Carry out the measurement.

⑥



Value of interference voltage.

Read out test results:

The value of measured resistance.

Note:

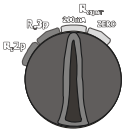
- Calibration performed by the manufacturer takes into account the resistance of supplied measurement leads of 1.2 m and 2.2 m

Additional informations displayed by the meter

U_x 30 V > 24 V and ⚠	Interference voltage is too high (> 24V) – the measurement is impossible. Turn off the source of interferences.
U_x 10 V > 50 V and ⚠ and continuous audio signal 🔊	**Interference voltage is above 50V!** **Immediately** disconnect the meter! Before re-connecting, turn off the source of voltage.
U_x OFL > 50 V and ⚠ and continuous audio signal 🔊	**Interference voltage is above 100V!** **Immediately** disconnect the meter. (symbol displayed instead of voltage value). Before re-connecting, turn off the source of voltage.
-r- and ⚠	Interruption in measuring circuit.
>1,99kΩ	R_E measuring range is exceeded.
NOISE!	Interference voltage is above 10V or unstable measurement result or measured voltages or currents are low in relation to noise.
noi 5 and ⚠ and long audio signal 🔊	Measured voltages or currents are too low in relation to noise or very unstable measurement result. (Symbol noi 5 is displayed instead of the result.)
°C and ⚠	Acceptable temperature inside the meter is exceeded.

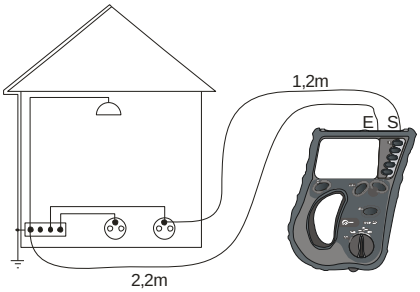
2.3 Measurement of the resistance of protective conductors and equipotential bondings

Attention:
When carrying out measurements of very low resistance, or when using leads other than original (1.2 m and 2.2 m) the calibration of test leads must be performed.

①  

Turn on the meter.
Set the rotational function selector at **R_{CONT} 200mA** position.

2



Connect the measured object to terminals **S** and **E** of the meter.

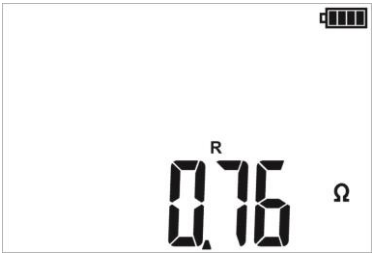
3

The meter is ready for measurement.

4

Press **START button**.
Carry out the measurement.

5



Read out the result.

Note:

- test current flows unidirectionally. To obtain results of a bidirectional current flow, the measurement should be repeated with replaced test leads and then respective arithmetic mean should be calculated from both measurements.

Additional informations displayed by the meter

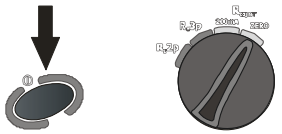
U_x > 3 V and ⚠	Interference voltage is too high (> 3Vrms) – the measurement is impossible. Turn off the source of interferences.
U_x > 50 V and ⚠ and continuous audio signal 🔊	**Interference voltage is above 50V!** **Immediately** disconnect the meter! Before re-connecting, turn off the source of voltage.
> 199Ω	R_{CONT} measuring range is exceeded.
NOISE!	Interference voltage with value of 1..3Vrms during R_{CONT} measurement. Obtained test results may be burdened with additional uncertainty.
noi 5 and ⚠ and long audio signal 🔊	Very unstable measurement result.

2.4 Calibration of test leads

In order to eliminate the impact of the resistance of test leads on measurement result, the compensation (autozeroing) of resistance may be performed. Therefore measurement function R_{CONT} has its sub-function called **AUTOZERO**.

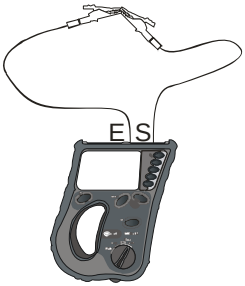
2.4.1 Activation of Autozeroing

1



Turn on the meter.
Set the rotational function selector at **R_{CONT} ZERO** position.

2



Short the test leads by putting crocodile clips on exposed ends of the test leads.

4

Press **START button**.
Perform Autozeroing.

5

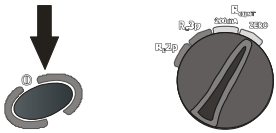
Autozeroing performed.

Note:

- remember that the resistance of crocodile clips and crocodile-banana connections is added to the resistance of the test leads.

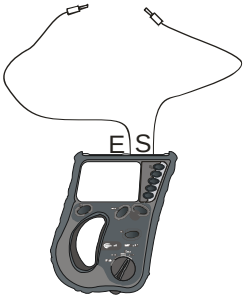
2.4.2 Switching-off Autozeroing

1



Turn on the meter.
Set the rotational function selector at **R_{CONT} ZERO** position.

2



Open out the test leads.

4

Press **START button**.

5

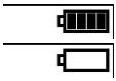
Autozeroing was turned off by the user.
During measurements the meter will compensate the resistance of original test leads (1.2m and 2,2m.)

Attention:
It is sufficient to perform single compensation for the test leads. It is stored in memory even after turning off the meter.

3 Power supply of the meter

3.1 Monitoring of the power supply voltage

The level of the charge of the batteries or rechargeable batteries is currently indicated by the symbol in the right upper corner of the display:


Batteries (or rechargeable batteries) charged

Batteries (or rechargeable batteries) low.

Batteries (or rechargeable batteries) need charging!

Note:

- The symbol bAt displayed on the display indicates insufficient power supply voltage and the need to charge or replace batteries.
- Measurements carried out with insufficient meter power supply voltage are distorted with additional errors which are impossible to ascertain by the user and thus they cannot constitute a basis for a conclusion of correctness of the tested earthing.

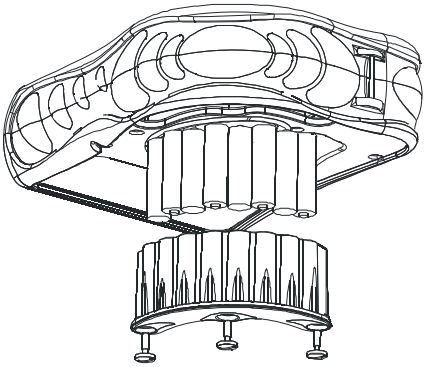
3.2 Replacement of batteries (rechargeable batteries)

MRU-20 Meter is powered by eight batteries or rechargeable batteries R6 (it is recommended to use alkaline batteries). Batteries (rechargeable batteries) are inserted into a container in the bottom part of the casing.

WARNING:
Before replacing the batteries (or rechargeable batteries), disconnect the test leads from the meter.

In order to replace batteries or the set of rechargeable batteries it is necessary to do the following:

1. Remove all the test leads from the measurement circuit and turn the meter off,
2. Remove the battery compartment (in the bottom of the case) after loosening three screws,
3. Replace all batteries (rechargeable batteries). New batteries or rechargeable batteries must be inserted observing the correct polarity ("-" on the springy part of the contact plate). Incorrect position of batteries will not damage the meter or batteries, but the meter with incorrectly inserted batteries will not work.
4. Insert the battery compartment and fix it with screws.



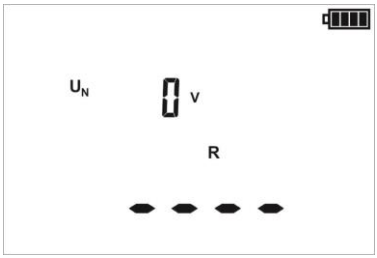
After replacing batteries/ rechargeable batteries the meter, after switching it on, will operate in power supply selection mode.

Selected power supply: rechargeable batteries.

Pressing **SEL push-button** will change the power supply to batteries.

Another pressing of the push-button will switch the selection again to rechargeable batteries.

Pressing **START** push-button will confirm the choice and the meter will be ready for measurement.



NOTE!
After replacing batteries (rechargeable batteries), set the type of power supply in order to enable correct display of battery charging level (charging characteristics of batteries and rechargeable batteries are different).

NOTE!
If batteries leak inside the battery compartment the meter should be serviced.

Rechargeable batteries should be charged in an external charger.

3.3 General principles regarding using Ni-MH 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 rechargeable batteries in a dry, cool and well ventilated place and protect them from direct sunlight. Ambient temperature in case of prolonged storage should not exceed 30°C. If the rechargeable batteries are stored for a long time in a high temperature, then occurring chemical processes may reduce their lifetime.

- NiMH rechargeable batteries are usually last for 500-1000 charging cycles. This rechargeable batteries reach their maximum capacity after being formatted (2-3 charge and discharge cycles). The most important factor which influences the lifetime a rechargeable battery is the level of its discharging. The deeper the discharge level, the shorter lifetime of a rechargeable battery.

- The memory effect is limited in case of NiMH rechargeable batteries. These rechargeable batteries may be charged at any point with no serious consequences. However, it is recommended to discharge them completely every few cycles.

- During storage, Ni-MH rechargeable batteries are discharged at the rate of approximately 30% per month. Storing rechargeable batteries in high temperatures may increase this rate even to 60%. In order to prevent excessive discharge of rechargeable batteries, after which it would be necessary to format them, it is recommended to charge the accumulators from time to time (even if not used).

- Modern quick-chargers detect both too low and too high temperature of rechargeable batteries and they react to this situation adequately. When the temperature is too low, charging is prevented as it may irreparably damage rechargeable batteries. Increased temperature of rechargeable batteries is a signal to stop charging and it is a typical phenomenon. However charging at high ambient temperatures reduces the lifetime of batteries and causes faster increase of their temperature, preventing charging to the full capacity.

- Remember that in the case of quick charging, rechargeable batteries are charged to approximately 80% of their capacity; better results may be obtained if the process of charging is continued: the charger goes then to the phase of charging with a low current and after next couple of hours the rechargeable batteries are charged to their full capacity

- Do not charge or use rechargeable batteries in extreme temperatures. Extreme temperatures reduce the lifetime of batteries and rechargeable batteries. Avoid locating devices powered by rechargeable batteries in very hot places. The nominal working temperature must be absolutely observed.

4 Cleaning and maintenance

NOTE!
Apply only maintenance methods specified by the manufacturerin this manual.

The casing of the meter and its case may be cleaned with a soft, damp cloth using all-purpose detergents. Do not use any solvents or cleaning agents which might scratch the casing (powders, pastes, etc.).

Clean the probes with water and dry it. Before the probes are stored for a prolonged period of time it is recommended to grease them with any machine lubricant.

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

The electronic system of the meter does not require maintenance.

5 Storage

The following recommendations must be observed to ensure proper storing of the device:

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

6 Dismantling and utilization

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

Worn-out electronic equipment should be sent to a collection point in accordance with regulations related to Waste Electrical and Electronic Equipment.

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

Observe the local regulations concerning disposal of packages, worn-out batteries and accumulators.

7 Technical data

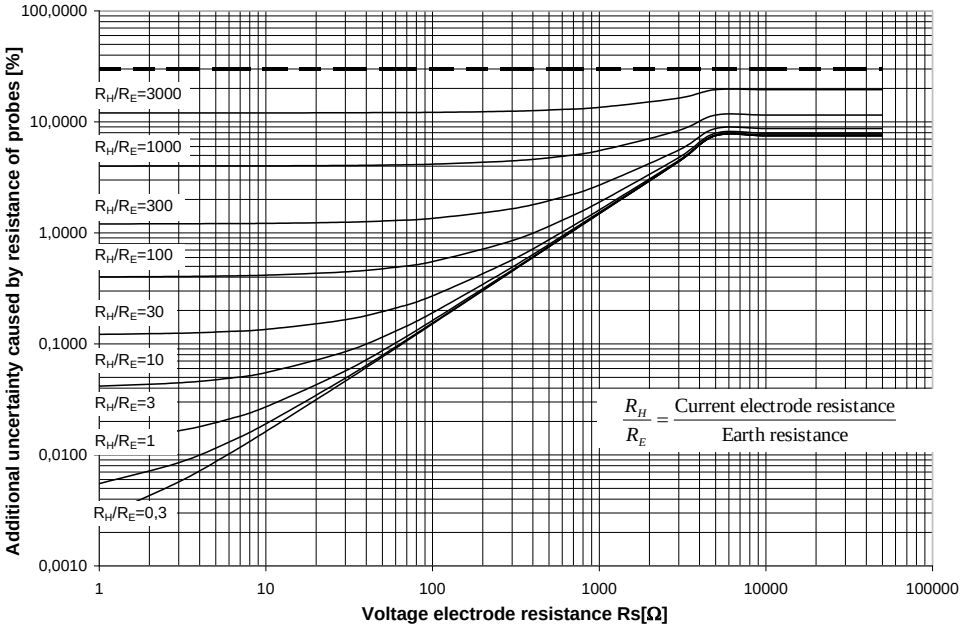
- Specified accuracy relates to terminals of the meter.
- „m.v.” abbreviation indicated standard measured value.

7.1 Basic data

Measurement of resistance-to-earth R_E
Measurement method: technical, according to IEC 61557-5
Test range according to IEC 61557-5: 0,50Ω ... 1,99kΩ for U_n=50V
0,68Ω ... 1,99kΩ for U_n=25V

Ranges of display	Resolution	Basic uncertainty
0,00...9,99Ω	0,01Ω	±(2% m.v. + 3 digits)
10,0...99,9Ω	0,1Ω	
100...999Ω	1Ω	
1,00...1,99kΩ	0,01kΩ	

- In the three-pole method, the uncertainty caused by resistance of probes is calculated and displayed by the meter. It can also be estimated using the following chart:



Influence of the resistance of electrodes on measurement uncertainty

Measurement of auxiliary electrodes resistance R_H, R_S

Ranges of display	Resolution	Basic uncertainty
000...999Ω	1Ω	±(5% (R_S + R_E + R_H) + 3 digits)
1,00...9,99kΩ	0,01kΩ	
10,0...50,0kΩ	0,1kΩ	

Measurement of interference voltages
Internal resistance: approx. 100kΩ

Range	Resolution	Basic uncertainty
0...100V	1V	±(2% m.v. + 3 digits)

Measurement of R_{CONT}
Measurement method: technical
Test range according to IEC 61557-4: 0,13…199 Ω

Display range	Resolution	Basic uncertainty
0,00...9,99Ω	0,01Ω	±(2% m.v. + 3 digits)
10,0...99,9Ω	0,1Ω	
100...199Ω	1Ω	

Note: Only values containing tolerances or boundary values are considered as guaranteed data. Values without tolerances are for informational purposes only.

Other technical data

a) type of insulation .....double, according to EN 61010-1 and IEC 61557
b) measurement category..... IV 300V according to EN 61010-1
c) degree of housing protection acc. to EN 60529 ..... IP54
d) maximum voltage of interferences at which R_E measurement is performed..... 24V
e) maximum voltage of interferences at which R_{CONT} measurement is performed..... 3V
f) maximum measured voltage of interferences 100V
g) frequency of R_E test current ..... 125 Hz
h) test voltage R_E.....25V or 50V
i) test current R_E 20mA
j) maximum resistance of test electrodes 50kΩ
k) R_{CONT} measuring current (with shorted terminals for $U_{BAT} \geq 9,0V$) 200mA
l) maximum voltage on open terminals for R_{CONT}..... 13V
m) power supply of the meter ..... alkaline batteries or NiMH rechargeable batteries, size AA (8 pcs)
n) number of R_E measurements .....> 1000 (5Ω, 2 measurements /min.)
o) dimensions.....260x190x60 mm
p) weight of the meter with batteries ..... approx. 1.3 kg
q) display..... LCD with a backlight
r) working temperature .....-10..+55°C
s) nominal temperature.....+23 ± 2°C
t) storage temperature .....-20°C..+70°C
u) relative humidity .....20..90%
v) relative humidity nominal .....40..60%
w) altitude (above sea level).....<2000m
x) time of automatic switch-off..... 5 minutes
y) electromagnetic compatibility .....according to EN 61000-6-3 and EN 61000-6-2
z) quality standard, execution, design and manufacturing are ISO 9001 compliant

7.2 Supplementary data

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

7.2.1 R_E Measurement

7.2.1.1 Additional uncertainty caused by resistance of auxiliary electrodes

$\delta_{dod} = \pm\left(\frac{R_S}{100000 + R_S} \cdot 150 + \frac{R_H \cdot 0{,}004}{R_E} + 1{,}5 \cdot 10^{-8} \cdot R_H^2\right)$ [%]	$R_S < 5k\Omega$
$\delta_{dod} = \pm\left(7{,}5 + \frac{R_H \cdot 0{,}004}{R_E} + 1{,}5 \cdot 10^{-8} \cdot R_H^2\right)$ [%]	$R_S \geq 5k\Omega$

R_E, R_H and R_S are values indicated by the meter in [Ω]. The above uncertainty is calculated by the meter and displayed as **ER**.

7.2.1.2 Additional uncertainty caused by serial interference voltage

R_E	Additional uncertainty [Ω]
0,00...9,99Ω	$\pm(0{,}01R_E + 0{,}012)U_z \pm 0{,}003U_z^2$
10,0...99,9Ω	$\pm(0{,}001R_E + 0{,}05)U_z \pm 0{,}001U_z^2$
100Ω...1,99kΩ	$\pm(0{,}001R_E + 0{,}5)U_z \pm 0{,}001U_z^2$

7.2.1.3 Additional uncertainty caused by ambient temperature:

± 0,25 digits /°C

7.2.1.4 Additional uncertainties according to IEC 61557-5

Operational uncertainty or significant parameter	Reference conditions or range of use	Designation	Additional uncertainty
Position	Reference position ±90°	E_1	0
Supply voltage	$U_{nom} \div U_{min}$	E_2	0
Temperature	0 ÷ 35°C	E_3	according to the formula defined in 7.2.1.3
Serial interference voltage	3V	E_4	according to the formula defined in 7.2.1.2
Resistance of probes and auxiliary earth electrodes	From 0 to 100R_E, but ≤ 50kΩ	E_5	according to the formula defined in 7.2.1.1
Operational uncertainty	$B = \pm\left(\lvert A \rvert + 1{,}15\sqrt{E_1^2 + E_2^2 + E_3^2 + E_4^2 + E_5^2}\right)$ where A = basic uncertainty		

7.2.2 Measurement of R_{CONT}

7.2.2.1 Additional uncertainty caused by ambient temperature:

±0,15%/°C

7.2.2.2 Additional uncertainties according to IEC 61557-4

Operational uncertainty or significant parameter	Reference conditions or range of use	Designation	Additional uncertainty
Position	Reference position ±90°	E_1	0
Supply voltage	$U_{nom} \div U_{min}$	E_2	0
Temperature	0 ÷ 35°C	E_3	according to the formula defined in 7.2.2.1
Operational uncertainty	$B = \pm\left(\lvert A\rvert + 1{,}15\sqrt{E_1^2 + E_2^2 + E_3^2}\right)$ where A = basic uncertainty		

8 Equipment

8.1 Standard Equipment

Standard set of equipment supplied by the manufacturer includes:

- MRU-20 meter – **WMPLMRU20**,
- AA batteries (8 pcs)
- set of test leads:
  - lead (30m), red, on a reel, ended with banana plugs – **WAPRZ030REBBSZ**,
  - lead (15m) on a reel, ended with banana plugs – **WAPRZ015BUBBSZ**,
  - lead (2.2m), black, ended with banana plugs– **WAPRZ2X2BLBB**,
  - lead (1.2m) blue, ended with banana plugs **WAPRZ1X2REBB**,
  - crocodile clip, blue K02 – **WAKROBU20K02**,
  - crocodile clip, black K01 – **WAKROBL20K01**,
- earth contact test probe (rod) 30cm (2 pcs) – **WASONG30**,
- carrying case for the meter and its equipment – **WAFUTL4**,
- harness for the meter – **WAPOZSZE2**,
- operating manual,
- calibration certificate.

8.2 Optional Equipment

Additionally, the following items not included in the scope of standard equipment may be purchased from the manufacturer or the distributors:

WAPRZ025BUBBSZ

- *Test lead, 25m (blue)*

WAPRZ050YEBBSZ

- *Test lead 50m*

WAPOZSZP1

- *reel for winding test leads*

WASONG80

- *earth contact test probe (rod) (80 cm)*

WAFUTL3

- *probe protective cover 80cm*

WAZACIMA1

- *cramp*

LSWPLMRU20

- *calibration certificate*

9 Manufacturer

The manufacturer of the device, which also provides guarantee and post-guarantee service is the following company:

SONEL S.A.
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58-100 Świdnica
Poland
tel. +48 74 858 38 60
fax +48 74 858 38 09
E-mail: export@sonel.pl
Web page: www.sonel.pl

Attention:
Service repairs must be realized only by the manufacturer.

WARNINGS AND INFORMATIONS DISPLAYED BY THE METER

NOTE!
The meter is designed to operate at interference voltages below 24V for R_E measurements and below 3V for R_{CONT} measurements.Voltage values up to 100V are measured, but above 50V they are indicated as dangerous. The meter must not be connected to voltages exceeding 100V.

> 24V and ⚠	In R_E measurement, interference voltage > 24Vrms - measurement impossible. Turn off the source of interferences or during R_E measurement try to arrange probes differently.
> 50V and ⚠ and continuous audio signal	**In R_E measurement, interference voltage > 50V!** **Immediately** disconnect the meter! Before re-connecting, turn off the source of voltage.
> OFL and ⚠ and continuous audio signal	**In R_E measurement, interference voltage > 100V!** **Immediately** disconnect the meter! Before re-connecting, turn off the source of voltage.
> 3V and ⚠	In R_{CONT} measurement, interference voltage is too high (> 3Vrms) - measurement impossible. Turn off the source of voltage.
> 50V and ⚠ and continuous audio signal	**In R_{CONT} measurement, interference voltage > 50V!** **Immediately** disconnect the meter! Before re-connecting, turn off the source of voltage.
-r- with the name of an electrode (electrodes) and ⚠	Interruption in measuring circuit or resistance of test probes is higher than 60kΩ. Please check connections in the measuring circuit or reduce the resistance of the measuring probe by its repositioning.
Er (under "Cell") and measurement result and ⚠	Uncertainty of R_E measurement introduced by the resistance of electrodes exceeds 30%. Reduce the resistance of the probe by its repositioning, or increase the dampness of the ground in the direct vicinity of the probe.
>1,99kΩ	R_E measurement range is exceeded.
>199Ω	R_{CONT} measurement range is exceeded.
>50kΩ	Resistance of test probes is higher than 50kΩ (but lower than 60kΩ).
OFL	Interference voltage for R_E is higher than 100V (symbol displayed instead of voltage value).
NOISE!	Interference voltage with value 1..3Vrms during R_{CONT} measurement. Obtained test results may be burdend with additional uncertainty. In R_E measurement, interference voltage > 10V or unstable measurement result or measured voltages or currents are low in relation to noise.
noi 5 and NOISE!	Measured voltages or currents are too low in relation to noise. (Symbol noi 5 is displayed instead of the result.)
OFF	In R_{CONT} function, the factory value of wiring resistance was restored. Autozeroing of wires was turned off by the user.
	Indication of battery level. Batteries (or rechargeable batteries) charged. Batteries low. After replacing batteries (rechargeable batteries), set the type of power supply, in order to enable correct display of battery charging level (charging characteristics of batteries and rechargeable batteries are different).
bAt	Discharged batteries (or rechargeable batteries) prevent stable oporation of the device. Replace batteries or recharge rechargeable batteries.
Err and error number displayed on main field of the display	Error detected by self-monitoring. MRU-20 devices are often exposed to strong electromagnetic interference, which may affect the content of internal registers. The meter automatically controls some parameters and if necessary, displays error messages. Error message may by cosed by temporary influence of external factors. Therefore, turn off the device and turn it back on. If the problem persists, the meter should be serviced.
°C and ⚠	Acceptable temperature inside the meter is exceeded.

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