DIGITAL MICRO-OHMMETER

32000 points autorange 100nΩ ÷ 3200Ω

mod. 20044

USER MANUAL

PROFESSIONAL MEASURING INSTRUMENTS

20044 MAN_GB.DOC SEPTEMBER 2021

INDEX

INTRODUCTION

The handheld digital microohmmeter mod. **20044** is an extremely advanced color touch display instrument capable of providing performance found in laboratory instruments.

- *Numerical and graphical representation of the measure*
- *Language selectable between Italian and English*
- *32000 measuring points / 4 measurements per second*
- *7 ranges from 3200Ω to 3200µΩ (from 100mΩ to 100nΩ of resolution)*
- *choice of automatic or manual range measurement*
- *2,8” color touch display with 320x240 pixels*
- *bar graph*
- *choice and display of the extent of measurement filtering*
- *Auto Shut Off selectable*
- *backlight adjustable between 10% and 100%*
- *7 different auxiliary measures of resistance and resistivity compensated and not compensated with temperature on the basis of different materials and settings by the user*
- *relative measure of absolute and percentage type referred both to a reference measure and to a set value*
- *minimum and maximum measurements*
- *battery charge status indication*
- *operation with 5Ah lithium battery*

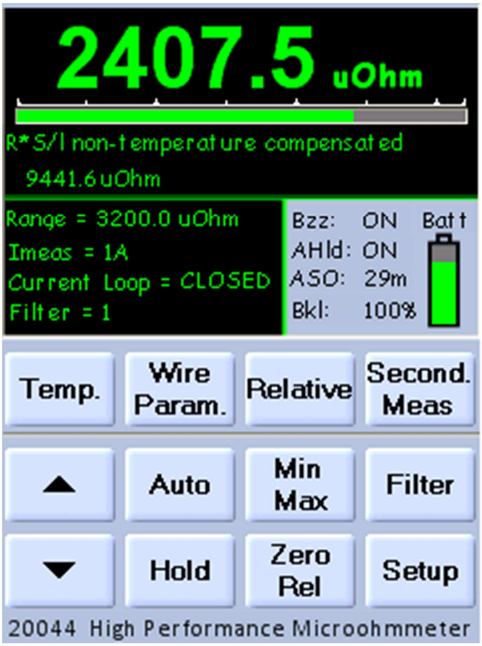
Accuracy, number of measurement points and resolution, menu in Italian and English, as well as reduced size and weight, make this instrument certainly unique considering that it is mainly intended for use in the field. In fact, the presence of internal rechargeable batteries release the need for mains voltage, with an autonomy that can reach tens of hours.

A lot of information is present on the main window, together with the measurement, but by accessing other windows it is possible to set and select the desired operating conditions and the parameters concerning the secondary measurement, as well as view the measurement as a graph.

On the front there are four bushings (**A+**, **A-**, **V+**, **V-**), two of which provide for the measuring current and two for the detection of the voltage drop across the resistor. The four-wire method makes it insensitive the measure from resistance of the wires that carry the current and the various contact resistances in the circuit *microohmmeter - test leads - unknown resistance*. The input signal is then amplified and compared with the reference internal resistance: the result, properly prepared and processed by a microprocessor, is shown on the display.

The numerous windows displayed will be illustrated in detail on the following pages.

MAIN window



Main measure

In the upper part of the window, the main measurement is displayed together with the unit of measurement.
Depending on the color, other information is provided.

Green The measure is fully valid and correct.

Red The measurement is in Auto Hold, ie "frozen" on the last valid measurement before the opening of the current circuit.
Auto Hold can be activated / deactivated in the **SETUP** window.

Light blue Together with the flashing, it indicates that the full scale of the measurement has been exceeded with the writing **OVL**.

Bar graph

It provides the same indication as the main measure, but in the form of a bar graph.
If the measurement is correct the bar is green and starts from the left side and extends to the right.

Conversely, if the measurement is negative (because the current terminals have been incorrectly connected inverted with respect to the voltage ones) the bar is orange and starts from the right side extending to the left..

Secondary measure

Immediately below the bar graph there is the area dedicated to the secondary measurement that can be chosen from 7 different options, selectable in the **SECONDARY MEASUREMENT** window, plus another 6 measurements that can be directly activated by the **Min Max** and **Zero Rel** button.

In this area, both a brief explanation of the chosen secondary measure and, in the line below, the value of the secondary measure is given.
On the basis of the parameters set in the other windows, the calculated values of the secondary measurement can also be considerably different, for some orders of magnitude, from the main measurement. This will become clearer when we talk about selecting the secondary measure.

Auxiliary information

Range	Indicates the selected range
Imeas	Indicates the current used for the measurement
Current Loop	Indicates whether the current loop is open → **OPEN** written in red or closed → **CLOSED** in green
Filter	Indicates the filtering value in the sequence 1-2-4-8-16-32-64-1-2-4 -..... corresponding to the number of acquisitions used to perform the average with which to represent the main measurement. The desired filtering is selected using the **Filter** button.
Bzz	Indicatesi f the buzzer is active → ON or deactivated → OFF The function of the buzzer is to acoustically indicate that a button has been pressed. It can be activated / deactivated in the **SETUP** window.
AHld	Indicates if Auto Hold is active → ON or deactivated → OFF The function of the Auto Hold is to "freeze" the last measurement made before the opening of the current circuit, so as to have the measurement even with the leads disconnected. It can be activated / deactivated in the **SETUP** window.

ASO	If active it indicates the remaining time, in minutes, to the instrument's Auto Shut Off, while if it is disabled, the message **No**. When the battery is completely discharged, automatic shutdown occurs even if the Auto Shut Off time has not expired or has been deactivated. In the last minute before the auto shutdown, the remaining time is indicated in seconds. By pressing any button the Auto Shut Off time resumes from the selected value. The setting can be selected in the **SETUP** window but, apart from the main window, in all the other windows, including that of the graphic viewer, the Auto Shut Off timer is never active and the instrument can switch off only after the selected time has elapsed, when the main window is displayed. In fact, the graphic viewer allows a representation of unlimited duration, regardless of the setting of the ASO timer.
Bkl	Indicates the backlight percentage of the screen, variable between 10% and 100%. It is selectable in the **SETUP** window.
Batt	Indicates the state of charge of the instrument battery while changing the color from green (fully charged battery) to red (low battery).

Buttons

Temp

Opens the window for setting the temperature parameters: room temperature, final temperature, temperature coefficient alpha, type of material.

Wire Param.

Opens the window for setting the parameters relating to the cable: area, diameter and length.

Relative

Opens the window for setting the relative reference value.

Second Meas

Opens the window for selecting the desired secondary measurement.

▲

Select the higher ohmmetrically range, until reaching the range of 3200Ω.

▼

Select the lower ohmmetrically range, until reaching the range of 3200μΩ.

Auto

Activates / deactivates the automatic range selection mode.
It is not possible to activate this mode if the hold of the measurement has been activated using the **Hold** button. It is essential to deactivate the manual hold before you can activate the auto range.
The Auto Hold that can be activated in the **SETUP** window becomes operational only if the instrument is not in auto range.

Hold

Freeze the measurement by highlighting its condition by putting the value of the main measurement in red.
By placing the instrument in Hold, the automatic range selection mode is disabled, if this mode was active.
The Auto Hold that can be activated in the **SETUP** window becomes operational only if the instrument is not in auto range.

Min Max

Enables/disables the simultaneous display of the minimum and maximum values during normal measurement, as long as the current circuit is closed.

Zero Rel **Multifunction button**

Zero

By pressing the button for less than a second, the instrument resets the main measurement, indicating this mode with the writing ***Zeroed*** to the right of the main measurement itself, above the unit of measurement.
This allows you to reset any potential contact or offset of the measurement amplifier or to perform relative measurements with respect to a reference measurement.
To correctly perform the zeroing due to various causes, refer to the **CONTACT POTENTIALS** paragraph in the chapter **TIPS ON THE MEASUREMENT EXECUTION** on pages 28 - 29.
Pressing the button again for less than a second exits the zeroing mode and the word ***Zeroed*** disappears.

Rel

By keeping the key pressed for more than one second, it is possible to activate the secondary measurement by displaying a relative measurement that can be selected from four different possible ones.
At the beginning the absolute relative measure appears, which uses the main measure as a reference value (***initial value***) when this option is activated.

Absolute from measure

in this case the secondary measure is

absolute = present value - initial value

By briefly pressing the button again, it is possible to select the calculation of the relative percentage measurement from measurement, that is using the main measurement as a reference value at the time of activating this option.

Percentage from measure

in this case the secondary measure is

percent = 100 * (present value - initial value) / initial value

By briefly pressing the button again, it is possible to select the absolute relative measurement from reference, that is using the value set in the **RELATIVE** window as a reference.

Absolute from reference

in this case the secondary measure is

absolute = present value - reference value

where the reference value considered is that set in the **RELATIVE** window accessible via the **Relative** button.

By briefly pressing the button again, it is possible to select the relative percentage measurement from reference

Percentage from reference

in this case the secondary measure is

percent = 100 * (present value - reference value) / reference value

where the reference value considered is that set in the **RELATIVE** window accessible via the **Relative** button.

By briefly pressing the button, the cycle is repeated, starting again from the absolute relative measurement using the main measure as a reference value. At any time keeping the button pressed for more than one second deactivates the secondary measurement.

Filter

Each time the button is pressed, a different filtering value is selected in the sequence 1-2-4-8-16-32-64-1-2-4 -..... The number which is also displayed in the center of the screen in the auxiliary information area after the word **Filter**, indicates the number of acquisitions used to calculate the average, which is nothing more than the measurement represented.
The greater the number of measures on which the average is performed, the slower the response of the instrument.
While maintaining a frequency of update of the measurement on the display of 4 Hertz, has the advantage of better stability of the representation.

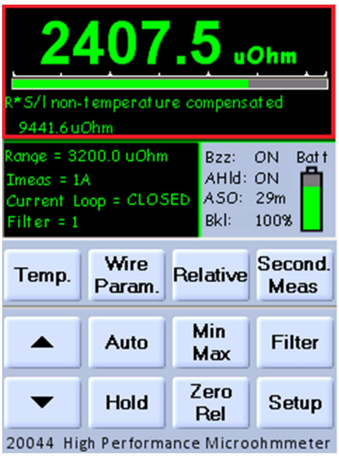
Setup

Opens the window where you can set some setup parameters.

Only from the main window and the graphic viewer window is it possible to manually turn off the instrument.

Access to the graphic viewer window

Even if there is no dedicated button, you can access the graphic viewer window simply by touching the area of the main window that has been highlighted in red in the image below.



GRAPH VIEWER window

Having the need for a graphic representation, this window can be displayed by touching the area of the main window highlighted in red in the image on the previous page.
The measure shown is only the main measure and no negative graphical values are displayed.
Trying to start recording with negative values for 2.5 seconds, the message **No START: Negative measure** appears.
With the available commands it is possible to set the vertical sensitivity and the offset, in order to bring the graph to the center of the display, while the acquisition speed is fixed at 2 acquisitions per second.
The range and filtering remain those selected in the main window.

Graphic

The graphic display has a size of 240 points horizontally and 200 points vertically allowing a fixed duration of what is displayed of 120 seconds, with a time division every 15 seconds thanks to the 7 vertical lines that divide the graphic screen.

There is no possibility to save the displayed recording, but its duration is unlimited thanks to the automatic scrolling of the graph which can be stopped, restarted, deleted and changed in vertical sensitivity.
The 10 vertical subdivisions each correspond to what is indicated on the Ohm / div label, or the vertical sensitivity, the selection of which will be explained later.
Depending on the color in which the graph is presented, other information is provided.

Green	The graphic representation is currently fully valid and correct.
Red	Recording was stopped with the **Start/Stop** button.
Light blue	The graphical representation has exceeded the minimum or maximum value that can be displayed on the graph. These limits depend on the sensitivity and offset selected.

Auxiliary information

***m*=**	Indicates the minimum measured value recorded up to that moment, even if the graphical representation exceeds the limits that can be displayed on the graph.
***V*=**	Indicates the current measurement value.
M=	Indicates the maximum measured value recorded up to that moment, even if the graphical representation exceeds the limits that can be displayed on the graph.

Buttons

<

Each time the button is pressed, a different value of the vertical sensitivity is selected, decreasing, in the sequence 3200 - 2000 - 1000 -…. - 20 - 10 - 5 - 2 - 1.
The selected value is automatically adapted to the active range both as the number of decimal digits (1,2 or 3 digits) and unit of measurement (Ω, mΩ or μΩ).
If you continue to press the button once the maximum sensitivity (value 1) is reached, a long acoustic signal is emitted. This sensitivity is equivalent to representing only 10 measurement points over the entire width of the graphic screen.
The graph is cleared each time the button is pressed.

>

Each time the button is pressed, a different vertical sensitivity value is selected, in increment, in the sequence 1 - 2 - 5 - 10 -…. - 1000 - 2000 - 3200. The selected value is automatically adapted to the active range both as the number of decimal digits (1,2 or 3 digits) and unit of measurement (Ω, mΩ or μΩ).
If you continue to press the button once the minimum sensitivity is reached (the value 3200), a long acoustic signal is emitted. This sensitivity is equivalent to representing the entire amplitude of 32000 measurement points of the instrument on the graphic screen.
The graph is cleared each time the button is pressed.

Ohm/div Indicates the sensitivity with which the graph is represented expressed in Ohm / division, representing it with the number of decimal digits and the unit of measurement depending on the range.
A division is equal to the distance between 2 adjacent horizontal lines visible on the display.
Since the number of divisions is equal to 10, the width of the display is equivalent to 10 divisions.

<<

Each time this button is pressed, the representation offset decreases by 200 points. Keeping it pressed for more than 1 second, the same parameter decreases rapidly.
When the value 0 (zero) is reached, a long acoustic signal is emitted.
The aim is to move the representation of the graph upwards so as to bring it into the center of the display, allowing you to maximize sensitivity.

<

This button behaves exactly like the previous one, except that the decrement is one unit each time it is pressed and the rapid decrement is also less.

>>

Each time this button is pressed, the representation offset is increased by 200 points. Keeping it pressed for more than 1 second you have a rapid increase of the same parameter.
The maximum achievable value is equal to the full scale of the measurement (32000 points) to which the maximum amplitude of the display representation is subtracted (10 times the sensitivity, or 10 times the Ohms / division). When this limit is reached, a long acoustic signal is emitted.
The aim is to move the representation of the graph downwards so as to bring it in the center of the display allowing to maximize the sensitivity.

$\boxed{>}$

This button behaves exactly like the previous one, except for the fact that the increase is one unit each time it is pressed and the rapid increase is also less.

Offset Indicates how far the graph is shifted to bring the visualization back to the center of the display.

Start / **Stop**

The button starts and stops recording.
Recording is not started if the measurement is negative and the message **No START: Negative measure** appears for 2,5 seconds.

Clear

Delete the recording by also clearing the minimum and maximum values.

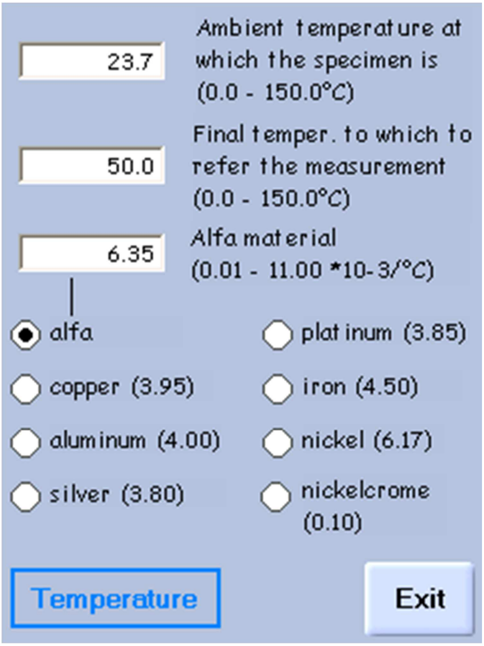
A/Offset

When this Auto Offset button is pressed, the instrument automatically calculates the offset value, also taking into consideration the selected sensitivity. The value can be changed with the fast/slow increment/decrement buttons of the offset.
This allows a quicker and easier identification of the optimal offset value compared to a "manual" setting.

Only from the main window and the graphic viewer window is it possible to manually turn off the instrument.

To allow unlimited graphical representation over time, without having to change the *Auto Shut Off* setting, the instrument does not perform any automatic shutdown selected in the Setup window.

TEMPERATURE window



This window is dedicated to setting the temperature parameters.
In this window it is possible to set and select some parameters concerning the compensation of the measurement based on the ambient temperature and the reference (or final) temperature, but also as a function of the temperature coefficient of the material, which in turn can be selected from predefined values or settable by operator.
In the upper part of the window there are two boxes where you can set the values regarding the ambient temperature at which the element under measurement is located and the temperature to which the calculation refers, as well as the box for entering the alpha coefficient.
The entry boxes are indicated respectively as:

Ambient temperature at which the specimen is

It is the ambient temperature at which the resistance measurement is performed.

Final temperature to which to refer the measurement

It is the temperature to which you want to refer / calculate the resistance value of the specimen.

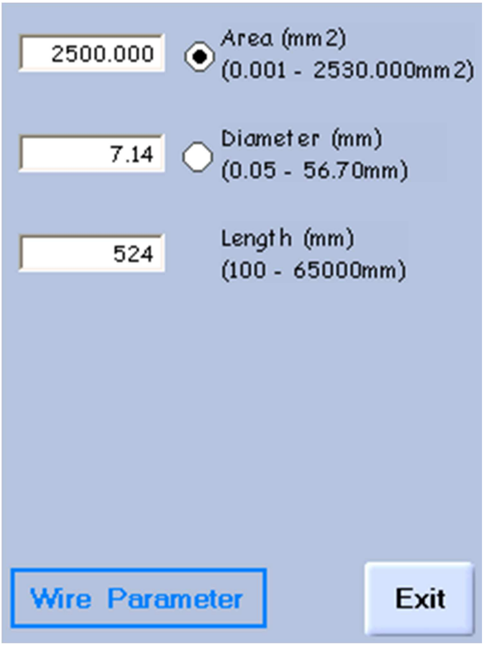
Alfa material

It is the alpha coefficient of the material that can be set by the operator, when a coefficient or material other than what is available or preset on the window is required.

In all cases the validity range of the parameter is indicated in brackets.
Touching the box relating to the parameter to be modified opens the window for entering the parameters, which will be described below.
This window also displays seven different materials among the most common used, each with its own name and, in brackets, the temperature coefficient expressed as 10-3 / ° C. If the desired material is not present or you think that the proposed coefficient does not correspond to the necessary one, you can also choose to use the alpha temperature coefficient set by the operator in the input box indicated by ***Alfa material***.
The secondary measurement that requires compensation with the temperature will automatically exploit the parameters set in this window obtaining

- *Ohm/meter temperature compensated*
- *Resistance * Area / Length (resistivity) temperature compensated*
- *Resistance of the main measurement temperature compensated*
- *Temperature compensated resistance according to EN 60228-2005-10 standard*

CABLE PARAMETERS window



The purpose of this window is to provide the instrument with information regarding the length of the cable whose resistance is being measured to go back, with the secondary measurement, to the Ohm / meter possibly compensated in temperature.
Taking into consideration also the area of the cable whose resistance is being measured or, if it is more convenient, equivalently the diameter of the cable, it is possible to calculate the resistivity (Resistance * Area / Length) also possibly compensated in temperature according to the parameters expressed in the **TEMPERATURE** window.

Area

Area of the cable being measured expressed in mm2.
This choice is an alternative to that of the diameter, if the area value is already available.

Diameter

Diameter of the cable being measured expressed in mm.

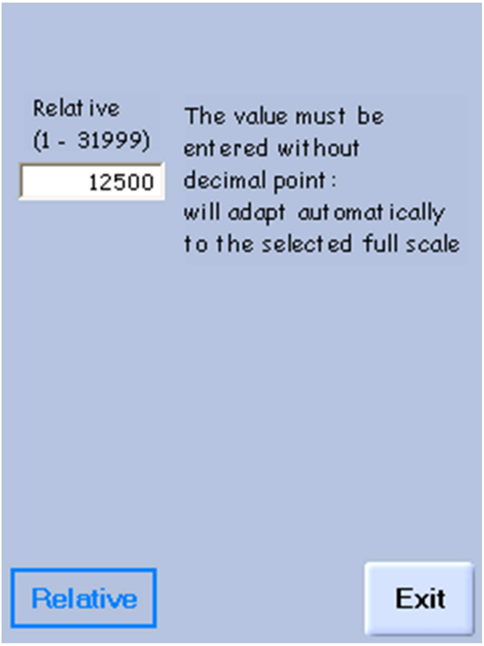
This choice is an alternative to the area and can be made on the basis of greater convenience in carrying out the mechanical measurement, also avoiding the calculation of the area.

Lenght

Length of the cable being measured expressed in mm.
For practical purposes this corresponds to the linear distance between the points where the + V and –V test leads measure the resistance of the cable.

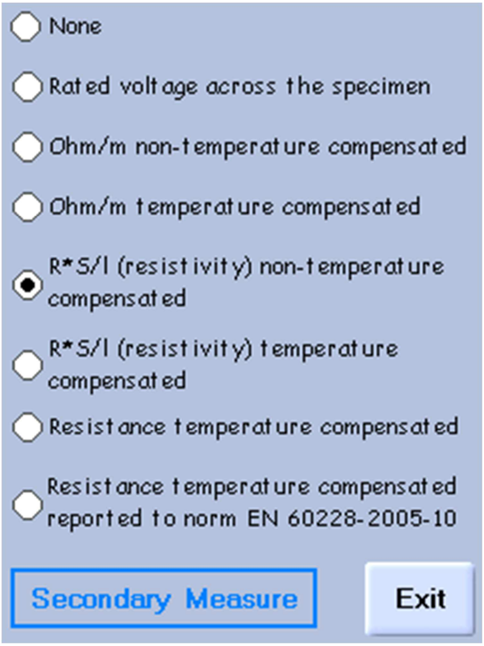
Touching the box relating to the parameter to be modified opens the window for entering the parameters, which will be described below.

RELATIVE window



Having the need for a relative measurement with respect to a predefined reference value, it is possible to set the value that appears in this window. With it it's possible to obtain both the absolute value and the percentage according to the selection made with the **Zero Rel** button in the main window.
It is not necessary to enter the decimal point as the value automatically adapts to the selected range.
Touching the box opens the window for entering the parameters, which will be described below.

SECONDARY MEASURE window



This is the window for selecting the desired secondary measurement and which, together with the various parameters that can be set in the other windows, will provide the data necessary to obtain what is desired.
The secondary measurements that can be obtained and the parameters involved are detailed below.

None

No secondary measurements are displayed.

Rated voltage across the specimen

The voltage across the resistance being measured is indicated.

Parameters used: *none*

Ohm/m non-temperature compensated

Indicates what resistance the cable whose resistance is being measured would have if it were 1 meter long.

Parameters used: - *Length* of the **CABLE PARAMETERS** window

Ohm/m temperature compensated

Indicates what resistance the cable whose resistance is being measured would have if it were 1 meter long and with temperature compensation.

Parameters used:
-*Length* of the **CABLE PARAMETERS** window
-*Ambient temperature at which the specimen is* in **TEMPERATURE** window
-*Final temperature to which to refer the measurement* in **TEMPERATURE** window
-*Alfa material* or *Material selection* in **TEMPERATURE** window

R*S/l (resistivity) non-temperature compensated

It indicates the resistivity value not compensated in temperature, that is the resistance value that a cable with a section of 1mm2 and a length of 1 meter would have, starting from the cable being measured with the area and length set in the **CABLE PARAMETERS** window.

Parameters used:
-*Length* in **CABLE PARAMETERS** window
-*Area* or *Diameter* in **CABLE PARAMETERS** window

R*S/l (resistivity) temperature compensated

Indicates the temperature compensated resistivity value, i.e. the resistance value that a cable with a section of 1mm2 and a length of 1 meter would have, starting from the cable being measured, with the area and length set in the **CABLE PARAMETERS** window and temperature compensated using the parameters set in the **TEMPERATURE** window.

Parameters used:
-*Length* in **CABLE PARAMETERS** window
-*Area* or *Diameter* in **CABLE PARAMETERS** window
-*Ambient temperature at which the specimen is* in **TEMPERATURE** window

-*Final temperature to which to refer the measurement* in **TEMPERATURE** window

-*Alfa material* or *Material* selection in **TEMPERATURE** window

Resistance temperature compensated

Indicates the resistance value of the main measurement, but temperature compensated on the basis of the parameters set in the **TEMPERATURE** window.

Parameters used:

-*Ambient temperature at which the specimen is* in **TEMPERATURE** window

-*Final temperature to which to refer the measurement* in **TEMPERATURE** window

-*Alfa material* or *Material* selection in **TEMPERATURE** window

Resistance temperature compensated reported to norm EN 60228-2005-10

Indicates the resistance value of the main measurement, but temperature compensated on the basis of the parameters set in the **TEMPERATURE** window and referred to a predefined final temperature of 20°C.

Parameters used:

-*Ambient temperature at which the specimen is* in **TEMPERATURE** window

-First and second order temperature coefficients of copper indicated in the EN 60228-2005-10 standard

PARAMETERS ENTRY window

The parameter entry window has an identical structure for all parameters, but for each parameter it indicates its name, validity range and actual value.

Each time this button is pressed, the rightmost number is deleted, so that in case of incorrect typing, the correction can be made.

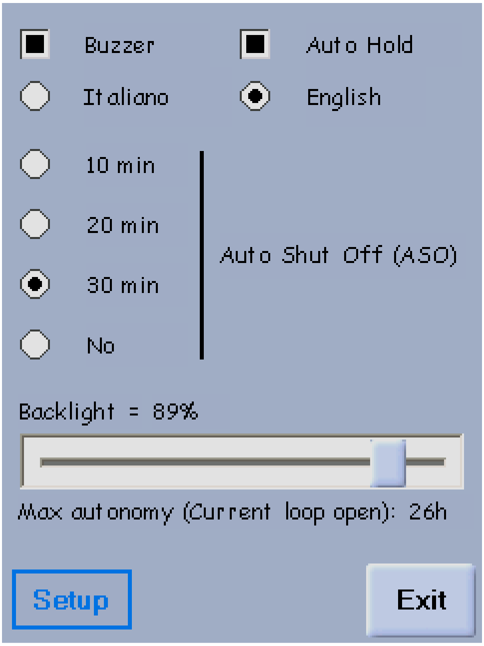
Save

It allows you to save the parameter while exiting the window.
If you try to save a value lower or higher than the allowed limits, the saving is not carried out, but a message appears indicating that the limit has been exceeded.

Cancel

Allows you to exit the window without saving.

SETUP window



This window allows you to set the operating conditions of the instrument according to your preferences.

Buzzer Allows you to activate / deactivate the buzzer, whose function is to acoustically indicate that a key has been pressed.

Auto Hold Allows you to activate / deactivate the auto hold, whose function is to "freeze" the last measurement made before opening the current circuit.
This mode becomes operational only if the instrument is not in the auto range mode.

Italiano/English Allows the selection of the desired language used for the menu, buttons and signals.

Auto Shut Off Sets an auto shutdown time, in minutes, which determines automatic shutdown after the selected time of 10, 20 or 30

minutes. If any button in the main window is pressed, the Auto Shut Off time is reset to the selected value.
In the last minute before the auto shutdown, the remaining time is indicated in seconds.
To disable this function, select **No**.
When the battery is completely discharged, automatic shutdown occurs even if the Auto Shut Off time has not expired or has been deactivated.

Backlight Using the slider you can set the brightness of the screen.
In addition to indicating the percentage value, an estimate of the battery autonomy of the instrument, assumed to be fully charged, is provided, assuming the current circuit is op.

INPUTS

On the panel there are the measurement inputs, present with the four bushing indispensable if we want to measure of low and very low value resistances with the Kelvin method, the battery charging socket and the on/off button.

A+ / A- **Current Bushings**

These terminals supply the measurement current. At no-load (with open current mesh) the voltage present at the output is about 2V.

V+ / V- **Voltage Bushings**

Through these terminals the voltage drop across the unknown resistor is detected, with a sensitivity of 1µV on all ranges. The only exception is the range of 3200µΩ, where the sensitivity is 0.1µV.

PWR **On/Off button**

By holding the button down for over one second, the instrument is switched on/off. Shutdown can only take place from the main page.
When turned off, all the parameters and settings made are saved in the instrument's non-volatile memory and recalled when turned on.

CHARGING **Led + Battery charger socket**

Also on the panel there is a LED that signals when the battery charger is connected to the instrument.
The charger socket is instead placed on the side of the container.
Charging takes place in a maximum of 10 hours, considering the battery completely discharged. The LED is normally on during charging, while at the end of the charge, beyond 10-12 hours or in any case when the battery maintenance voltage is reached, the LED may switch off or fluctuate in brightness.

TECHNICAL SPECIFICATIONS

Power supply	3.7V 5.0Ah lithium cell
Battery	visual indication of charge status battery
Battery autonomy	view Tab. 2
Battery charger	100-240v 1,5A
Charging time	10 hours max
Representation	on backlighted color graphic display 240x320 pixels 2.8”
Language	Italian and English
Points of measure	32000
Display refresh rate	4 Hz
Ranges	3200,0µΩ, 32,000mΩ, 320,00mΩ, 3200,0mΩ, 32,000Ω, 320,00Ω, 3200,0Ω
Range selection	automatic / manual
Automatic change of scale	switch to range higher >31999 points switch to range lower <3000 points
Resolution and measuring current	view Tab. 1 **RESOLUTION AND MEASURING CURRENT**
Measurement accuracy (ranges 3200Ω ÷ 32mΩ)	±(0,05% + 2 digit)
Measurement accuracy (range 3200µΩ)	±(0,06% + 3 digit)
Noise (referred to input from 0,01Hz to 0,1Hz)	0,2µV_{pp} con filtro = 16
Open circuit voltage (**A+**) - (**A-**) (current circuit open)	2,0 Vmax
Graphic representation	virtual display of 240x200 points (horizontal x vertical) of unlimited duration
Vertical sensitivity of the graphic representation	between 1 point / div and 3200 points / div
Graphical representation visible on the virtual display	240 acquisitions, equal to 120 seconds with subdivisions every 15 seconds
Filter	average on 1, 2, 4, 8, 16, 32, 64 measures
Working temperature	0 ÷ 50 °C
Storage temperature	-20 ÷ 60 °C
Weight	320 gr. approximately
Dimension	159x78x34mm

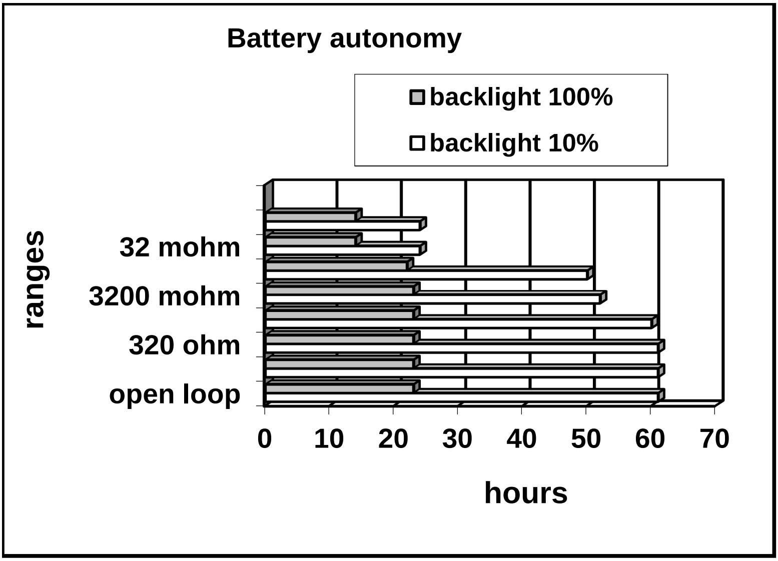
The table below shows the values of resolution, measuring current and maximum power dissipated by the unknown resistance depending on the selected full scale.

RESOLUTION AND MEASURING CURRENT					
Range	**Resolution** (resistance)	**Resolution** (voltage)	**Voltage of f.s.**	**Current**	**Maximum power**
3200µΩ	100nΩ (10^{-7} Ω)	0,1µV	3,2mV	1A	3,2mW
32mΩ	1µΩ (10^{-6} Ω)	1µV	32mV	1A	32 mW
320mΩ	10µΩ (10^{-5} Ω)	1µV	32mV	100mA	3,2mW
3200mΩ	100µΩ (10^{-4} Ω)	1µV	32mV	10mA	320µW
32Ω	1mΩ (10^{-3} Ω)	1µV	32mV	1mA	32µW
320Ω	10mΩ (10^{-2} Ω)	1µV	32mV	100µA	3,2µW
3200Ω	100mΩ (10^{-1} Ω)	1µV	32mV	10µA	0,32µW

Tab. 1 Summary table of the resolutions, sensitivity, measuring current and maximum power dissipation of the unknown resistance as a function of the selected range.

The charging current of the battery charger of about 700mA is able to charge the battery at the same time and to supply energy to the instrument or to power it if you wish not to use the batteries.

Below is the graph concerning the battery autonomy, without connection to the network, according to the range selected and the on/off status of the display backlight.



Tab. 2 Graph representing the battery autonomy in function of the selected range and the status of the backlight.

TIPS ON THE MEASUREMENT EXECUTION

CONTACT POTENTIALS

After switching on the instrument, before taking any measurements, it would be advisable to wait at least 10 minutes. This allows the necessary thermal settling of the components of the micro-ohmmeter.

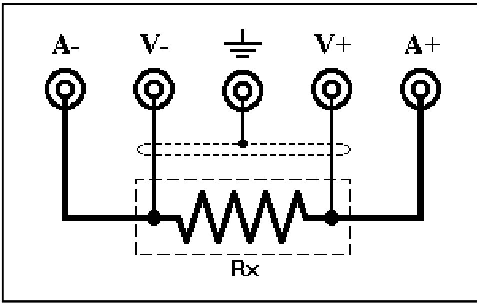


Fig. 3 Connection diagram for measuring four wires of a resistor of low value.

In carrying out the measure is essential, in order to obtain the best results, follow the connection diagram of the terminals of measurement shown in Fig 3. In this way it is avoided that in the circuit voltage there are the contact resistances of the current terminals, with a macroscopic alteration of the measurement results.

With cables of Kelvin type this problem does not exist since the two tweezers placed to end are connected in such a way as to avoid that the contact resistances adversely affect the measurement.

Other sources of error may be the potential of contact that you have when two different metal materials meet.

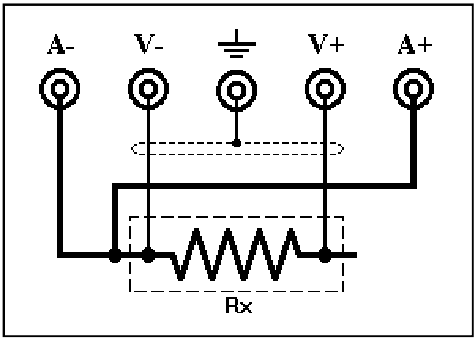
To minimize the influence of this physical phenomenon, it must try to have the same type of contact between positive and negative terminal voltage and the unknown resistance. This contemplates both the state of the surfaces (polished, oxidized, dirty, etc..) that the material (other than material of a head of the unknown resistance compared to another), as well as the different temperature at which they can be the points of contact of the element under test.

If the type of contact to the positive terminal is similar to the negative terminal, the two effects tend to cancel and at most remains a potential equal to the difference of the two. If this effect remains constant over time is sufficient to compensate him once and for all, on the contrary should be periodically reset by pressing **Zero Rel** button.

The change that you mention is mainly due to variations in temperature between the two points where the voltage probes touch the unknown resistance: the only way to get a stable and reliable measure is to take every precaution to ensure that immediately after an zeroing there are not fluctuations in the temperature difference of the two points of contact.

All the above said phenomena are, in absolute value, certainly modest (generally a few tenths of microvolts), but unfortunately they are more than detectable by instruments of similar sensitivity. That's why it is essential to take some basic and essential precautions to have a good quality of the measurement. The main, but not the only ones, are:

- Clean the surfaces of the terminals of the unknown resistance and measuring cables from oil, water, oxides etc.
- Wait for the cooling of the object to be measured.
- Avoid heating/cooling, even slightly and in whatever way, a terminal of the resistor to be measured relative to each other.
- Avoid concatenate the measurement cables with varying magnetic fields that can cause a bad reading.
- Always perform a zero when entering the 3200μΩ range or connecting the test leads to another resistor.
- To obtain a correct zeroing of the instrument and to guarantee a measurement as precise as possible, the voltage leads / terminals must not be moved after performing a zeroing.
  If you want to check or carry out the correct zeroing of the instrument and the relative contact potentials of the voltage terminals, it is **ABSOLUTELY ESSENTIAL** to use the configuration shown in the diagram below, where **ONLY ONE** of the current terminals is **MOVED**.



Since the contact potentials can vary from point to point, it is essential, in order to have the best results, not to move the measurement points, even if they are assumed to be equipotential: different current flows and different contact potentials in different points alter the measurement. This is absolutely valid if you want to perform a good zeroing: the electrical connection of the voltage terminals between the measurement and zeroing phases must never be altered.

ELECTROMAGNETIC FIELDS

Other causes of instability or failure of the measurement or in zeroing are attributable to the presence of magnetic fields can induce electrical noise can move the level in DC of the signal. The best way to mitigate this influence is to keep the test leads, both current and voltage, as short as possible and neighbors, ensuring also that the test leads do not wobble or vibrate in proximity to static magnetic fields: this will cause the occurrence of induced voltages of amplitude and frequency dependent on the movement.

SLOW OF MEASUREMENT

This is certainly not a cause of the error, but it may seem, sometimes, that the instrument is too slow or even stop it: the reason is due to the value that has been set in the filter. The higher this value, the longer the time that the instrument takes to make a series of measurements on the unknown resistance.

MEASUREMENT OF HIGHLY INDUCTIVE ELEMENTS

The microhmmeter **20044** is able to measure the resistive component also of inductive elements such as transformers with powers of over 1 MVA. To avoid damage or malfunctions of the instrument it is advisable to connect a diode in parallel to the unknown element as shown in Fig. 4.

However this protection diode should only be placed if there is actually a need, ie on inductive loads. A 1A diode such as 1N4004 or similar is sufficient.

Its function is mainly to protect the amperometric circuit. The voltage circuit is protected against continuous differential voltages up to ± 35V and pulse up to ± 100V for 1 second.

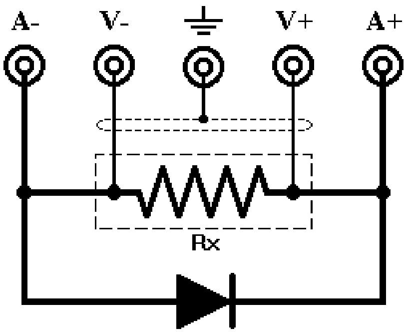


Fig. 4 Connection diagram of the protection diode in parallel with an strongly inductive element. Note the direction of insertion of the diode.

CAUTION:	It is important that the protective diode is connected in parallel to inductive element and not between the terminals of current or voltage, otherwise it is not able, disconnecting current cables, to eliminate the strong glitter that is created. The spark can also reach voltages of thousands of volts and irreparably damage some electronic circuits of the current generator.

PROTECTION FROM OVERVOLTAGE AND OVERCURRENT

The instrument is provided with adequate protection against voltage surges on voltage inputs, as specified in the technical specifications, but requires, in the case of measurement of predominantly inductive elements, an external protective diode. Such a diode as shown in the previous section, is fully sufficient to protect the generator current circuit. This does not mean, however, that the instrument is able to withstand electrical stress such as connection to motors or transformers connected to its power supply, especially if this is the line network. The electric power at stake in this case would be well beyond those tolerable by the protection circuitry, internal and external, of microohmmeter and its damage would be certain.

CAUTION:	The instrument is not able to bear, on the bushings of measurement, the application of external voltages or currents, especially if due to the direct connection with the network line.

MEASUREMENT PERFORMED ON 3200μΩ RANGE

This range is the only one to have a voltage sensitivity of only 0.1μV, against a sensitivity of 1μV of all the others. This makes it more susceptible to the various disturbing effects listed in this chapter, but a minimum of attention and possibly an zeroing is sufficient, as suggested in the **CONTACT POTENTIALS** paragraph, to guarantee a correct measurement.

TEST CERTIFICATE

INSTRUMENT MODEL	. . . . .	**20044**
SERIAL NUMBER INSTRUMENT	. .	____________________
BATTERY	. . . . . .	**OK**
TEMPERATURE of CALIBRATION	. . .	_____________

RANGE	RESISTANCE of REFERENCE	MEASURED VALUE	PRECISION DECLARED	RESULT
3200Ω			**0,5 ‰ + 2dgt**	**OK**
320Ω			**0,5 ‰ + 2dgt**	**OK**
32Ω			**0,5 ‰ + 2dgt**	**OK**
3200mΩ			**0,5 ‰ + 2dgt**	**OK**
320mΩ			**0,5 ‰ + 2dgt**	**OK**
32mΩ			**0,5 ‰ + 2dgt**	**OK**
3200µΩ			**0,6 ‰ + 3dgt**	**OK**

TEST NOISE	. . . . .	**OK**
TEST EMC	. . . . . .	**OK**
TEST BURN-IN	. . . . . .	**OK**
MANUAL, CABLES, SOFTWARE	. . . .	**OK**

This is to certify that the instrument conforms to the technical specifications relating thereto, as stated in the specifications.

Date The Operator

_______________ ___________________

DECLARATION OF CONFORMITY

The company PEDRANTI ELIO, Via Cesare Battisti 33/B, Cardano al Campo - Varese, Italia, declare under our sole responsibility that the instrument **20044**, to which this declaration relates, is in conformity with the rules laid down in directive CEE89/336.

Cardano al Campo, 15/01/21 . *Pedranti Elio* .