DIGITAL MICRO-OHMMETER

for high current measurement

12000 points 10nΩ ÷ 1200mΩ 300Amax

mod. 20040

USER MANUAL

PROFESSIONAL MEASURING INSTRUMENTS

20040 MAN GB.DOC SEPTEMBER 2015

CAUTION !!!

Before using the instrument, read this user manual carefully and in particular the measurement procedure.
An improper use of instrument could lead to dangerous situations for the safety of people.

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Introduction

The digital microohmmeter mod. **20040** is a instrument specifically designed for the measurement of the contact resistance of the power contactors and for the verification of the junction of power bars. Obviously it is capable of measuring even simple purely resistive elements. It is not suitable for the measurement of inductive elements such as inductors and transformers, even if small.

Its salient features are:

- *12000 measuring points / 2 measurements per second*
- *5 ranges from 1200mΩ to 120μΩ (from 100 μΩ to 10 nΩ of resolution)*
- *settable measuring currents up to 300A in steps of 5A*
- *measurement times can be set in various ways / values*
- *smart color display with resistive touch 4,3" 480x272 pixels*
- *save up to 200 measurements each with: ohmic value, voltage seen on Rx, current measurement, power dissipation of Rx, date and time of the saving data with resolution of the second and message up to 180 characters*
- *language: Italian and English*
- *alert windows with various detailed signaling messages in case of incorrect settings or selections*
- *bar graph of 240 points*
- *back light adjustable froml 20% to 100%*
- *acoustic signal activable/deactivable*
- *measure hold activable/deactivable*
- *reading data and setting via optocoupled USB*
- *only two commands: one to read all the data and one to read saved measures and notes*

Accuracy, number of measuring points, maximum resolution and minimum size, low weight and unique presence, for this category of instruments, a touch screen display which governs the entire microohmmeter, make this instrument definitely cutting edge.

On large high brightness display 4.3 " there are also various auxiliary information such as the measurement current, the voltage across Rx and the power dissipated on it, the number of saved measurements and the time remaining before the end of measure or elapsed since the beginning the measure, depending on the measurement mode setup. Everything is designed to be easily readable and always available.

The instrument of type analog-digital is housed in a container in plastic material of high resistance in the form of briefcase. Weighing about 8,85Kg, it has a handle that facilitates transport, but was also considered ease of use, reducing the functions to those strictly needed leaving any processing software on PC.

The entire unit is operated by a smart touch screen display that displays the measurements, the softkeys of range selection, setup button, viewing and saving measures button and zeroing button.

The amplifier and converter are in a monolithic device so as to have an very low equivalent input noise. The measurement technique is ratiometric to four wires, known as the Kelvin connection: the only one which allows very high accuracies and resolutions. The connections are made via two power contacts screw for supplying the measuring current and by means of two bushings for the voltage reading.

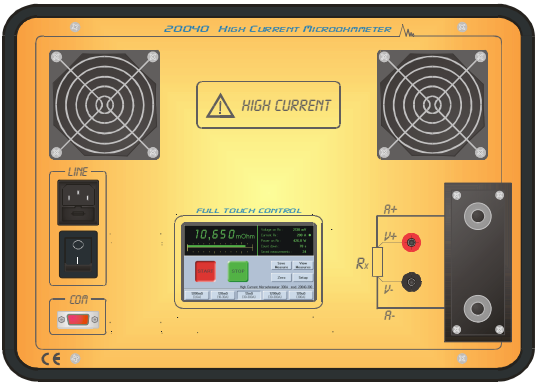

Fig. 1 View of the front of the instrument with the grates of cooling fans, the power socket and the power switch, the communications port, the smart display and connections of current and voltage.

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*. Measured the voltage across Rx and the current circulating in it has been calculated the ratio by known relationship R = V / I, determining the resistance value Rx displayed.

The high currents that can be set for the measurement are for urge the device under test. The upper and lower ranges of the instrument are the only ones with fixed current values; the others ranges have currents set by the operator according to need.

Deliberately, for safety reasons, the instrument has only the manual selectable range. It is delegated to the awareness of the operator the selection of a given range and of the relative measurement currents to avoid that in the transition from one range to another, in consideration of the high current and power available, the device under test can be destroyed.

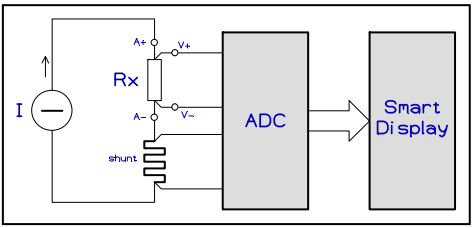

Fig. 2 Block diagram of the microohmmeter **20040** and the four-wire measurement.

Main window

Switching on the instrument

Between the instant when you press the power button and the appearance of the main page showed below elapse about 8-10 seconds.

In it are grouped measurement data and the various buttons that determine its operation.

Language, range and setting of acoustic signal and hold of measure are saved as configuration and are called automatically when the instrument is started.

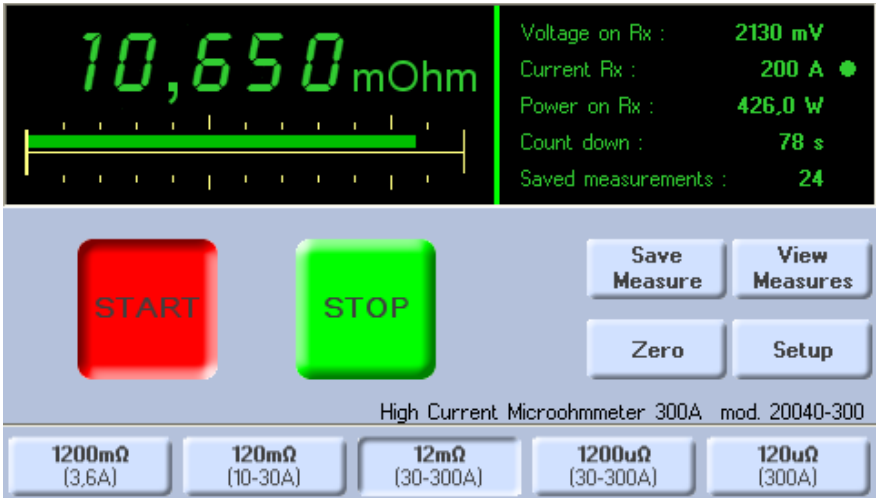

Fig. 3 It is visible the main window during a measurement the case where the English language is selected.

MEASURES

At the top of the display are collected all the measures provided by the instrument.

When mode Hold is activated the main measurement and secondary data are shown in red, to highlight that, although represented, the measurement is stopped.

Main measure

Resistance is represented in numerical and bar graph mode. The bar graph have a maximum of 240 points.

In case of reverse connection of voltage (**V+** connected with **A-** and **V-** connected with **A+**) the numerical measurement is represented with a negative sign,
The bar graph will take on the color red instead of green, and will be at the bottom of the area dedicated to it.
The numerical value of the measure is displayed only after that the measuring current has reached the nominal value.

Voltage across Rx

It's the voltage detected at the terminals of the device under test.
Purposefully the resolution represented is lower than the actual measured by the instrument and used for the calculation of Rx, which is 1-2 digits greater.
The value represented is stored along with the value ohmmetrico when a measurement is saved.

Current in Rx

It's the actual current flowing through the device under test.
Purposefully the resolution represented is lower than the actual measured by the instrument and used for the calculation of Rx, which is 1-2 digits greater.
The resistance measurement is displayed only when the current reaches the nominal value.

During the increase of the current value appears near to it a blinking triangle facing upwards.

Upon reaching the nominal current value, the symbol becomes a circle.
If the measured current falls below 95% of the set value, the circle will start flashing.

Similarly during the decrease of the current to stop the measurement, appears a blinking triangle facing down.

The measuring current value represented is stored along with the resistive value when a measurement is saved.

Power on Rx

It's the power dissipated by the device under test and the voltage and current used in the calculation are the ones actually read by the instrument, with a resolution greater than that represented on screen.

The real power supplied by the instrument may be much higher and exceed the kilowatts because it includes power dissipated from power cables.
The power value represented is stored along with the resistive value when a measurement is saved.

Remaining time / Elapsed time

The measurement mode can be timed or without limit. The label will change respectively in *Time remaining* or *Elapsed time*. The beginning of the counting takes place when the current in Rx reach the rated value of measurement.

Saved measurements

It indicates the number of measurements stored.
In addition to the resistance value are stored data of voltage, current and power, time and date, but also notes written by operator whose purpose is to provide additional information such as location, motivation, methods of measurement, operator name, etc.

DEFINITION OF BUTTONS

The only buttons on the device are software and are activated by touching the touch screen.

1200mΩ ÷ 120μΩ **Selection of ranges**

These five buttons are used for selecting the desired range.
At power is selected the last range saved.
To save in nonvolatile memory configuration the range that must be called on power is need pressing and holding the button of the desired range for about two seconds, or until you hear a second beep, if the buzzer is active (see the **Setup** window). Until it is saved to a new configuration, it will be called the previous range saved.
The saving can be done either immediately holding down the button for two seconds to a new range, that pressing the button of activate range.

Button pressed < 1 sec **Select the new range**

Button pressed > 2 sec **Save the range in configuration**

During measurement, for safety reasons, it is not accepted a change of range or saving in the configuration. This prohibition is signaled by a continuous tone when you press one of the buttons concerned.

START **Start measurement**

Starts measurement.
For safety reasons, the current measurement is activated only after pressing the **START** button. The reason is simple: considering the high currents that can be generated is necessary to perform the connections to the device under test, in particular those of current, before starting to measure it.

CAUTION:	Do not start NEVER the measurement before completing the connection of the power cables, making sure that the tightening is correct and complete. A tightening slack could overheat the connection points.

Measuring current gradually rises to the programmed value (see the Setup window) and the **START** button stay pressed until it is activated the **STOP** button.
If you press the **START** button again after the start of the measurement it's generated a long acoustic error message.

STOP **Stop measurement**

Stop measurement.
You can stop the measurement at any time, even during the current rise, immediately after pressing the **START** button.

Save Measure **Saving the measure**

Stores the value of the measure in act, with auxiliary details of voltage, current, power, date and time.
If you press the button when the measurement is stopped, it will show the window that warns of the impossibility to implement the command, displaying a notice in the language selected in the **Setup** window.

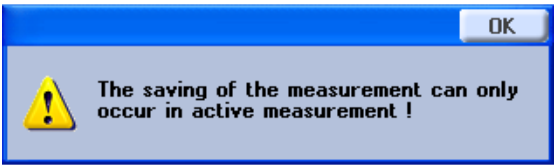

Fig. 4 The notice indicates the inability to save a measure if this it's not active.

View Measures **Open window of saved measurements**

Opens the window **Record** which lists the saved measurements.
All information about the features of this window can be found in the chapter **Window of saved measurements**.

Zero **Zeroing** **Multifunction button**

This button allows you to initiate a zeroing of the instrument, considering the value at that time as measured value of zero, or cancel a previous acquisition of "zero".
This button is always active.

Button pressed < 1 sec ***Acquisition of the new value of zero***

If the measurement is stopped….

Measurement is started just like pressing the **START** button, which in fact is shown pressed together with the **ZERO** button.
After that the measuring current has settled expects the settling of the measurement for 10 seconds, after which the value measured is taken as zero and the measurement is stopped. The settling time of 10 seconds is fixed and not dependent on the measurement time set by operator in the setup window.
In the event that the measured value exceeds ±1000 points, the warning appears indica-ting the impossibility to proceed with the reset.

Fig. 5 The notice indicates that it is not possible to continue resetting the instrument because the measured value is too high.

If the measurement is started ….

If the measuring current is in phase of increase or decrease appears this warning.
If the measure is valid and is within the accep-table limits of ±1000 points, is considered to be zero, otherwise appears

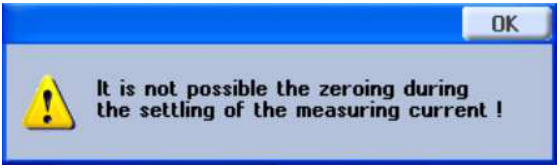

Fig. 6 In this case the message indicates that you can not continue resetting the instrument because the current has not reached the set value.

the warning of Fig. 5.

Button pressed > 1 sec ***Canceling the value zero***

If the measurement is stopped….

Initially you start the measurement with the activation of the **START** button, but after a second fall on the **STOP** button. We do not have any other visual indication of cancellation (or zeroing) of value of zero previously saved.

If the measurement is started….

It has no reset of the instrument because this is equivalent to cancel zeroing required when the button is pressed.

Setup **Open instrument's window setup**

This button opens the Setup window where you can set the time, date and other modes of operation of the instrument.

If the measurement is running you can not access the setup window, as shown in the warning of Fig. 7.

All information about the features of this window can be found in chapter **SETUP window**.

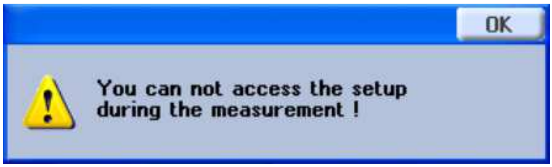

Fig. 7 The notice indicates that you can not open the setup window if the measurement is running.

SETUP window

In this window there are not volatile settings instrument. They are automatically called when you turn on this.
If the set values, selected or switched on/off are not saved with the **OK** button, you have the automatic restoration of settings prior to entry in the window.

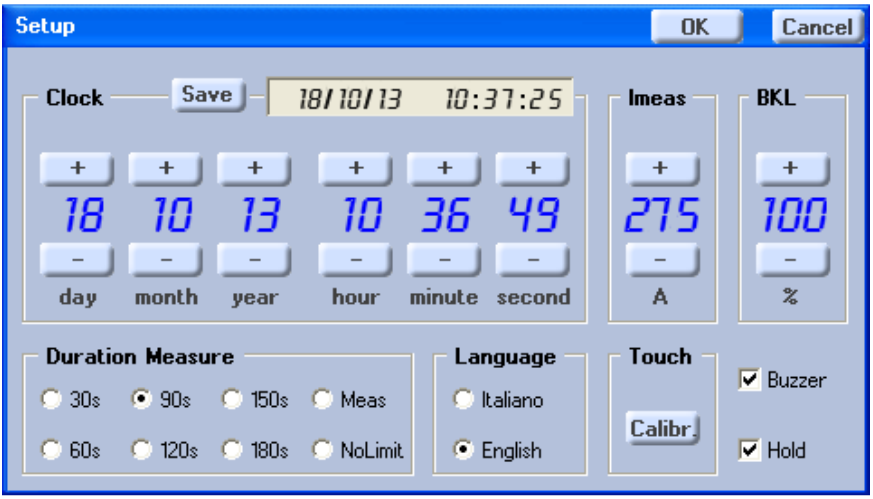

Fig. 8 The setup window is divided into dedicated zones to the various parameters that can be set by an operator.

Clock

Using the **+** and **-** buttons you can set the date and time of the internal clock of the instrument, synchronizing the set value when you press the **Save** button. This happens regardless of whether they to exit the window you use the **OK** or **Cancel** button.
In case of wrong setting appears a warning that reports the error.

Imeas

It is the nominal current measurement, set in steps of 5A between a minimum of 10A and maximum of 300A.
The real value may be slightly different, but the discrepancy does not exceed 5%. In any case the resistance value is calculated based on the actual current flowing through it, not on the set value.

Since some ranges have default current values, the set value does not always correspond to the actual current measurement. The following table summarizes the possible settings range by range.

Range	Setting current	Nominal measurement current	Notes
1200mΩ	any value	3,6A	The measuring current is preset to 3,6A, regardless of the setting
120mΩ	10 ÷ 30A	10 ÷ 30A	If you set a current of more than 30A, the current measurement is limited to 30A.
12mΩ	30 ÷ 300A	30 ÷ 300A	If you set a current of less than 30A, the current measurement is limited to 30A.
1200µΩ	30 ÷ 300A	30 ÷ 300A	If you set a current of less than 30A, the current measurement is limited to 30A.
120µΩ	any value	300A	The measuring current is preset to 300A, regardless of the setting

Tab. 1 Summary table of the current set and those actually used to carry out the measurement, depending on the selected range.

BKL

Set the backlight between a minimum of 20% and a maximum of 100%.

Duration Measure

Select the measurement duration between a minimum time of about 10 seconds, when is chosen ***Meas***, and a maximum time of 180 seconds.

Selecting ***NoLimit*** the measurement is stopped only by pressing the **STOP** button.

The measurement can also be stopped by pressing the **STOP** button also having selected any of the predetermined measurement times.

If you select a measurement time predetermined on the main window shows the message "**Count down:**", otherwise the writing is "**Elapsed time:**".

Language

Select your preferred language between Italian and English.

All warnings and messages appear in the selected language.

Touch

The **Calibr.** button open a completely black window with a small cross in the upper left of the screen and the text "*Press and hold the stylus on the centre of the target. Repeat as the target moves around the screen.*".
The aim is to calibrate the resistive touch on the screen if you believe there is a mismatch between image and corresponding touching area.
After calibration of the fourth point we have an automatic return to the **Setup** window.

☐ **Buzzer**

The option enables/disables the buzzer depending on whether you want or not to beep when buttons are pressed or warnings appear.

☐ **Hold**

The option enables/disables the hold, namely the possibility whether or not to freeze the display of the measurement when the measure is stopped.
When hold is active the measurement of resistance and auxiliary measurements are displayed in red, when the measurement is stopped and freezed, in order to highlight that it is not a measure updated and real.

DEFINITION OF BUTTONS

OK **Settings activation**

This button provides the permanent saving of setting and to return to the main window.
Clock synchronization occurs only at the set value by pressing the **Save** button.

Cancel **Clear the settings**

With this button you return to the main window without save and activate the settings.
If you synchronize your watch with the **Save** button, pressing the **Cancel** button does not cancel the synchronization.

Window of saved measurements

The measures that have been saved with the **Save Measure** button in the main window are listed here in chronological order. For each recording, you can clearly see the resistance value, the voltage measured at its terminals, the current passed through it, the power dissipated and the date and time.

All this information can be further integrated with a file of maximum length of 180 characters viewable and editable by opening another window with the **View / Edit** button.

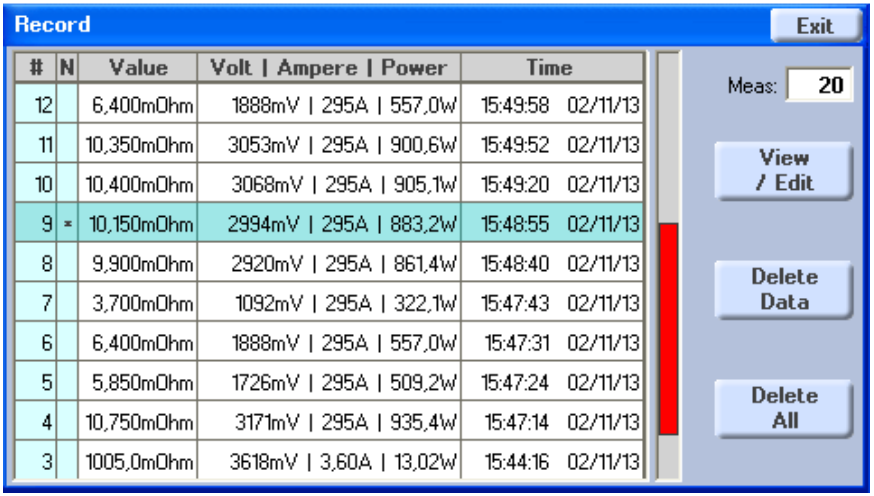

Fig. 9 The **Record** window lists the measures saved together with ancillary data and date and time. In column **N** (Notes) the presence of an asterisk indicates that a message has been saved.

The scrolling list can occur in three different ways:

- *If the scroll bar does not fill the entire vertical space you can click above or below the bar, depending on where you want to scroll the list, for coarse displacement.*
- *By clicking on the scroll bar, normally of orange color, this becomes red and, once engaged in this way, it is possible to slide it above or below obtaining the corresponding displacement of the list.*
  The vertical dimension of the bar is proportional to the amount of registrations visible compared to the save: since the maximum number of simultaneously visible measures are ten, if the bar is long 40% of the maximum, 25 are the saved measurements.

- *Click at any point of the list in the part where the background is white and move the finger (or stylus) upward or downward, depending on the necessity.*
  This option allows a much more controlled movement of slip, unlike the other two methods that generate large displacements.

The two columns on the left, with light blue background, they also serve to highlight the line of measurement: clicking on the column **#** or **N**, at the desired measure, you highlighting the entire line. In Figure 9 you can see the highlighting that allows, by pressing the **View / Edit** button, to open the file attached to the saved measurement highlighted.

The eventual asterisk indicates that there is already a file, which can be accessed and edited via the QWERTY keyboard.

If the recording of the measure has no attached message, simply highlight the corresponding line (by clicking on one of the two columns **#** or **N** as detailed above) and press the **View / Edit** button: opens a window with a QWERTY keyboard that allows you to edit the message.

DEFINITION OF BUTTONS

123 **Measures**

The box indicates the number of measurements stored in memory.

Exit **Window close**

Closes the Setup window and return to main window.

View / Edit **Show the message of a single registration**

Opens window with the QWERTY keyboard which has an area dedicated to the display of the message.

Delete Data **Remove the single registration**

Delete the selected data, but only after confirmation by the **YES Delete** button visible on window shown in Fig. 10. The request is canceled by pressing the **NO Exit** button.

Delete All **Remove all registrations**

Delete all the records, but only after the choice made using the buttons in the selection window on the right.

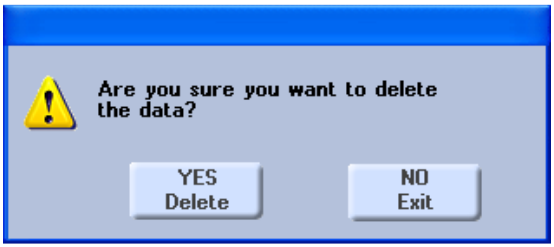

Fig. 10 With these buttons you can choose between deleting data or cancellation of the request of deleting.

QWERTY keyboard

It's a full QWERTY keyboard that allows the editing of two lines of text for a total maximum of 180 characters.

The keys in gray are a special keys acting on position of the cursor or mode of text insertion, deletion or line of text you write.

Figg. 11-12 Shows the two sets of keyboard characters selectable via special keys.

The following describes the function of each special key.

It serves to switch from one set of characters to another, but only momentarily, after which it returns to the series of previous characters.
If are represented lowercase (or uppercase) and serves a uppercase character (or lowercase) is possible, by pressing this button, go to the second set of characters. Immediately after entering the desired character, automatically returns to be shown the initial set of characters.

Switches permanently by a set of characters to another.

Change the mode of insertion of characters in the text alternating the symbol of cursor between "|" and "_".
When the cursor is represented by the symbol "|" the new characters you type are inserted between existing text.
If the symbol of cursor is "_" the new characters will overwrite to existing ones.
In the images of Fig. 11 and Fig. 12 it can be noted that the cursor, at the end of the second line, is represented by the vertical bar.

The function of these two buttons is to move the cursor right or left by one position each time you press the button.
Holding down the button will have, after a brief moment from first movement, the moving fast of the cursor in the direction corresponding to the key. If there are two lines of text, the cursor moves automatically from the beginning of a line at the end of the other and vice versa, depending on the button pressed.

This backspace key has the function to delete the character to the left of the cursor, regardless of the active cursor: insertion or overwrite.
Holding down the button will have, after a brief moment after first cancellation, the fast erase character to the left of the cursor.
Reached the left end of the bottom line automatically switches to the text line top "dragging" all characters of the bottom row or all those possible as filling of top line.

It has a function quite similar to the previous button, but deletes characters places to the right of the cursor.
Holding down the button will have, after a brief moment after first cancellation, the fast erase characters to the right of the cursor.

After deleting the last character to the right of the top line passes to erase even the characters of the text line below, if any.

Used to switch between text line top to text line bottom and vice versa, if they exist both. This in order to continue the writing of the text on the new line selected, which thus appears highlighted in yellow to indicate it is the active one.
If there is a single upper line the key moves in the bottom line all characters to the right of the cursor, independently of the type of cursor.
By placing the cursor before the first character left of the second row, if the cursor is "|", or under the first character left of the second row, if the cursor is "_", pressing the BS button (backspace), all characters in the bottom row that can fit in the empty part of the top line are transported on the top line.

With this key you save the text and exit the keyboard window.
If the text saved has even only one character, in the **Record** window, in correspondence of the highlighted recording to gain access to the keyboard, an asterisk appears in column **N**. If not saved any character no asterisk appear.

Inputs

On the panel there are the measurement inputs, present with two power connections with threaded holes for screws 10MA and a pair of bushings, the socket for the mains power supply, the power switch and the communication port.

A+ / A- **Connections of high current**

A connection is dedicated to the positive polarity, the other to the negative. They occur as the cylinder of 20mm in diameter with a threaded hole 10MA with depth of 25mm.
It is strongly recommended to tightly connect power cables, possibly with brass screws. Insufficient tightening may result in significant localized overheating when high currents are used, generally over the 100A.

V+ / V- **Connections of voltage**

They consist of normal bushings, one red for the positive polarity and a black one for the negative, to which are connected the cables for the voltage detection.

LINE **Power socket**

Power socket 90 to 260Vac 47 to 63Hz and 5x20mm fuse holder with fuse 10AT (230Vac) or 20AT (110Vac).

ON **Power switch**

Power switch.
As you power off the cooling fans are operating for 3÷5 seconds.

CAUTION:	Turn off the instrument only after stopping the measurement and disconnected cables of current and voltage.

COM **Communication port**

The opto insulated communication port of the instrument allows you to connect to a PC who can read the data, the instrument setup and measures saved in non volatile memory.
The interconnection module adapter is optional.

Technical specifications

Power supply	90÷260Vac 47-63Hz 10AT (230Vac) or 20AT (110Vac)
Power requirement	1800VAmax
Representation	smart touch display 4.3" 480x272 pixels with 16 million colors
Brightness backlight	280 cd/m^2 adjustable from 20% to 100%
Points of measure	12000
Display refresh rate	2 Hz
Range	120,00µΩ, 1200,0µΩ, 12,000mΩ, 120,00mΩ, 1200,0mΩ
Range selection	manual
Resolution	10nΩ, 100nΩ, 1µΩ, 10µΩ, 100µΩ
Measurement accuracy	±(1% + 5 digit) range 120,00µΩ ±(1% + 3 digit) range 1200,0µΩ, 12,000mΩ and 120,00mΩ ±(2% + 10 digit) range 1200,0mΩ
Measure current	120,00µΩ → 300A 1200,0µΩ → selectable from 30A to 300A in step of 5A 12,000mΩ → selectable from 30A to 300A in step of 5A 120,00mΩ → selectable from 10A to 30A in step of 5A 1200,0mΩ → 3,6A
Circuit voltage of the current terminals	6V approximately
Maximum power dissipation on load (connection cables including)	1500W approximately
Power cables available on request	2x5m 25mm^2 (nominal resistance overall of 8mΩ) 2x5m 50mm^2 (nominal resistance overall of 4mΩ) 2x10m 75mm^2 (nominal resistance overall of 5,3mΩ) 2x10m 95mm^2 (nominal resistance overall of 4,2mΩ)
Maximum length of power cables usable to 300A 25°C (nominal resistance overall of 16mΩ)	2x10m 25 mm^2 2x20m 50 mm^2 2x30m 75 mm^2 2x38m 95 mm^2
Measurement time	10sec, 30sec, 60sec, 90sec, 120sec, 150sec, 180sec and "NoLimit"
Rate of increase/decrease measuring current	50A/sec

Reading accuracy of the current measurement	better than 0,5%	range from 120,00µΩ to 120,00mΩ
	better than 1,5%	range 1200,0mΩ
Reading accuracy of voltage measurement	better than 0,5%	on all ranges
Input impedence voltmeter section	>1MΩ	
Saving measures	up to 200 measures, each with: resistance value, voltage across Rx, measuring current, power dissipation of Rx, date, time and eventual records up to 180 characters	
Measures retention time	no limit	
Clock/calendar	yes, as standard	
Battery autonomy clock/calendar	10 years (battery type: CR2032)	
Language messages	selectable Italian or English	
Optocoupled USB connection	with optional interconnection module USB adapter	
Weight	8,85 Kg approximately	
Dimension	410x325x175mm (W x H x D)	
Working temperature range	-20 ÷ +50 °C	
Storage temperature range	-30 ÷ +70 °C	

The table below shows the resolution values, measuring current and maximum rated power dissipated by the Rx element, function of selected full scale.

RESOLUTION AND MEASURING CURRENT					
Range	**Resolution** (resistance)	**Resolution** (voltage)	**Voltage of f. s.**	**Current**	**Maximum power**
120µΩ	10nΩ (10^{-8} Ω)	3µV	36mV	300A	10,8W
1200µΩ	100nΩ (10^{-7} Ω)	3 ÷ 30µV	36 ÷ 360mV	30 ÷ 300A	108W
12mΩ	1µΩ (10^{-6} Ω)	30 ÷ 300µV	360 ÷ 3600 mV	30 ÷ 300A	1080W
120mΩ	10µΩ (10^{-5} Ω)	100 ÷ 300µV	1,2V/3,6V	10 ÷ 30A	108W
1200mΩ	100µΩ (10^{-4} Ω)	360µV	4,32V	3,6A	15,55W

Tab. 2 Summary table of the resolutions, sensitivity, measuring current and maximum power dissipation of the unknown resistance as a function of the selected range.

Measurement execution

READ CAREFULLY THIS SECTION BEFORE USING THE INSTRUMENT.

IT'S ABSOLUTELY FORBIDDEN DISCONNECT CABLES DURING MEASUREMENT.

TURN OFF THE INSTRUMENT ONLY AFTER DISCONNECTED THE MEASUREMENT CABLES.

DO NOT CONNECT THE MEASUREMENT CABLES TO EXTERNAL VOLTAGES.

By following the simple guidelines exposed you can significantly reduce any dangerous situations that can arise during the measurement.

Selection of range and measuring current

Since the instrument is capable of supplying currents of up to 300A and power that reach 1500W, it is absolutely essential to put a lot of attention both during the preparatory measure and that during the measurement itself.

First of all select the suitable range, by setting the measuring current which ensures the best compromise between quality of the signal and stability of the measurement. In fact the higher the current and generally the better the signal/noise ratio. On the other hand a high current causes a heating of the part being measured leading to a possible change in resistance due to thermal effects.

Only the technician in charge of measurement can decide what is the maximum current to be taken for a specific item under test based on its experience, mass, shape, material and size of the piece. When in doubt it's absolutely essential to start with low current.

If the range does not allow selection of the measuring current or this choice is limited, as for the first two ranges, check, even through the tables Tab. 1 and Tab. 2 respectively on page 14 and 24, if what is to be measured it's able to withstand the power supplied.

In some cases the incorrect or clumsy range selection of measuring current can lead to incandescent, or even the merger, the part being measured.

Tightening of cables

It is also very important a correct tightening of the cables, that if it was too slack would lead to a heating or overheating, the interface between the screw and cable terminals or between terminals and cable. The increase of temperature in this area could in turn lead to an increase in temperature of the part being measured, altering its value ohmic.

In fact the power involved, at interconnection points, can also reach the considerable value of 10W, if the measured current is 300A and the contact resistance is approximately 1mΩ. To reduce the contact resistance is essential to tighten the screws and maximize the contact surface between the parts that make up the junctions.

It is also definitely much better to use brass bolts instead of steel since the latter presents an electrical resistivity between 2 and 10 times greater of brass. The direct consequence is a considerable heating of the steel screw, by the Joule effect due to the currents that will flow, so that tends to elongate by reducing the tightening, by increasing the contact resistance and contributing to a further increase in temperature.

Another possible cause of incorrect measurement due to localized heating is the difference of thermoelectric potential that in this way are created and detected by the voltage terminals connected to **V+** and **V-**.

Instrument's zeroing

During normal measures the connection between the instrument and an element to be measured is shown in Fig. 13, to the next page.

Sometimes it is necessary to perform a reset because you think there is an imbalance measuring amplifier or because, as mentioned in the previous paragraph, it is assumed the presence of potential thermoelectric or of contact uncompensated that can cause measurement errors. For this reason it is necessary to proceed to a momentary modification of the connections as shown in Fig. 14.

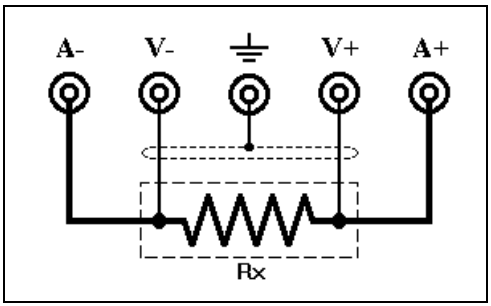

Fig. 13 Connection diagram for measuring four wires of a resistor of low value.

Also in this case it is essential to provide for correct tightening of the screws since the currents involved are the same as those used for the measurement.

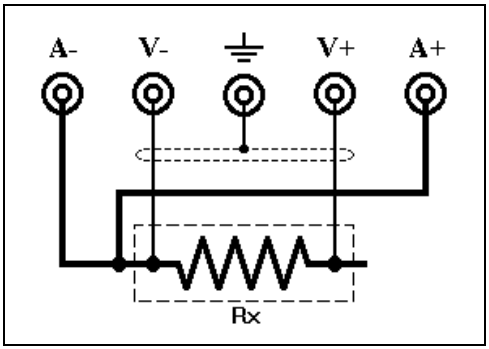

Fig. 14 Connection to be made during the compensation of the voltage drop on the current cables.

Communication port

Generality

The microohmmeter 20040 is equipped as standard with a USB interface optically isolated. Through appropriate optional module, which looks similar to a connector RS232 9-pin, you can connect the instrument to a PC to obtain the following information:

- *ohmic value*
- *voltage seen on Rx*
- *current measurement*
- *power dissipation of Rx*
- *remaining time / elapsed time*
- *measuring current set*
- *number of saved measures*
- *selected range*
- *status of the instrument (validity of measure, measurement started, selected language, etc.)*

Also you can:

- *download the entire sequence of measures saved along with the notes of each measure*

All this using only two commands:

- *a read request with which the instrument provides all the information available by sending a string of 17 bytes followed by an eighteenth byte of checksum*
- *a read request of the measures saved*

For safety reasons, you can not in any way make the change of instrument settings, launch or halt the measure through the serial connection. It is only permitted the reading of the data and saved measurements.

It is connected via virtual serial port set to:

-	baud rate	38400
-	start bit	1
-	data bits	8
-	stop bit	1
-	parity	none

Reading data – Request command 00H

For the reading of data is sent to a single request bytes with value 00H. The instrument responds with 17 bytes of data followed by a checksum byte terminal, as shown in the following table.

Some data are in the form of bytes (number of saved measurements, range and serial number), others in the form of the word as a set of two bytes (resistance, voltage, current, etc.), still others as a set of flags with fields from one to three bits.

# byte	Deinition	Type of data
1	upper byte of resistance (main measure)	word
2	lower byte of resistance (main measure)	
3	upper byte of voltage across Rx	word
4	lower byte of voltage across Rx	
5	upper byte of actual current in Rx	word
6	lower byte of actual current in Rx	
7	upper byte of power dissipated in Rx	word
8	lower byte of power dissipated in Rx	
9	upper byte of remaining time / elapsed time	word
10	lower byte of remaining time / elapsed time	
11	upper byte of measuring current set	word
12	lower byte of measuring current set	
13	number of saved measures	byte
14	range	byte
15	status1	flag
16	status2	flag
17	serial number instrument	byte
18	checksum	byte

Below we will specify in detail how to interpret the data received.
Indicated the word received with **XXXXX**, with many **X** how many decimal digits representing the maximum extent, it is possible to show with **x** the numbers after the decimal point.

If a hypothetical measure of 117,43mΩ (range code = 4), the value contained in the two bytes is considered to 11743, or XXXXX. The value interpreted is XXX, xx mΩ, precisely **117,43 mΩ**.

This mode of interpretation is valid for all the variables.

byte 1-2 Resistance

Is the signed value (2's complement) of resistance measurement and is provided without comma or units of measure. The proper interpretation depends on the range selected, as shown in the table.
To obtain the value, perform this calculation:

Range	Range code	Interpreted value
120μΩ	1	XXX,xx μΩ
1200μΩ	2	XXXX,x μΩ
12mΩ	3	XX,xxx mΩ
120mΩ	4	XXX,xx mΩ
1200mΩ	5	XXXX,x mΩ

resistance_value = byte1 * 256 + byte2

byte 3-4 Voltage across Rx

Is the signed value (2's complement) of voltage across the resistor and is provided without comma or units of measure.
The proper interpretation depends on the range selected, as shown in the table.
To obtain the value, perform this calculation:

Range	Range code	Interpreted value
120μΩ	1	XX,xx mV
1200μΩ	2	XXX,x mV
12mΩ	3	XXXX mV
120mΩ	4	XXXX mV
1200mΩ	5	XXXX mV

voltage_value = byte3 * 256 + byte4

byte 5-6 Actual current in Rx

It represents the value with sign (2's complement) of the actual measured current through the resistor Rx and is provided without comma or units of measure. It differs from the current value set because the latter is a nominal value, but also because not always the value of the set current coincides with that of measurement, as explained in the table Tab. 1 on page 14.
The proper interpretation depends on the range selected, as shown in the table.
To obtain the value, perform this calculation:

Range	Range code	Interpreted value
120μΩ	1	XXX A
1200μΩ	2	XXX A
12mΩ	3	XXX A
120mΩ	4	XX,x A
1200mΩ	5	X,xx A

current_value = byte5 * 256 + byte6

byte 7-8 Power dissipated in Rx

Is the signed value (2's complement) of power dissipated by the resistor and is provided without comma or units of measure.
The proper interpretation depends on the range selected, as shown in the table.
To obtain the value, perform this calculation:

Range	Range code	Interpreted value
120µΩ	1	X,xxx W
1200µΩ	2	XX,xx W
12mΩ	3	XXX,x W
120mΩ	4	XXX,x W
1200mΩ	5	XX,xx W

power_value = byte7 * 256 + byte8

byte 9-10 Remaining time / Elapsed time

Represents, in seconds, the elapsed time of the measurement, if you select the measurement mode **No Limit**. Conversely indicates the time remaining before the end of the measurement if you have selected any other mode:

time_value = byte9 * 256 + byte10

byte 11-12 Measuring current set

It is the current measurement set in the window **SETUP**. As explained by Tab. 1 on page 14 the current set and actual current measurement can be not the same.
To obtain the value, perform this calculation:

current_set_value = byte11 * 256 + byte12

byte 13 Number of saved measures

It indicates the number of measurements stored.

byte 14 Range

This byte contains a code corresponding to the selected range, as indicated in the table opposite.

RANGE	
Code	**Range**
0	*Not used*
1	120µΩ
2	1200µΩ
3	12mΩ
4	120mΩ
5	1200mΩ

byte 15 Status1

This byte is a set of four fields where it is summed up part of the state of the instrument. Bit *0* is the least significant, bit *7* the most significant.
The description of individual fields and corresponding identification codes is provided in the same table.

Status1			
# bit	**Binary weight**	**Meaning**	**Value**
0	1	Measure	0 = valid 1 = positive overflow 2 = negative overflow 3 = current circuit open
1	2		
2	-	Current generator started	0 = no 1 = yes
3	-	The current has reached the nominal value	0 = no 1 = yes
4	-	Started zeroing procedure	0 = no 1 = yes
5	-	*not used*	
6	-	*not used*	
7	-	*not used*	

byte 16 Status2

This byte is a set of four fields which complement the instrument status.
Bit *0* is the least significant, bit *7* the most significant.

Status2			
# bit	**Binary weight**	**Meaning**	**Value**
0	1	Measurement time	0 = 30s 1 = 60s 2 = 90s 3 = 120s 4 = 150s 5 = 180s 6 = duration minimally possible (10s) 7 = no time limit
1	2		
2	4		
3	-	Buzzer	0 = disabled 1 = enabled
4	-	Hold	0 = disabled 1 = enabled
5	-	Language	0 = Italian 1 = English
6	-	*not used*	
7	-	*not used*	

byte 17 Serial number instrument

Is the instrument's serial number.

byte 18 Checksum

Is the algebrical sum of seventeen bytes of data, truncated to the lower byte.
If hypothetically the sum of the byte corresponds to 03A2H (03A2 value in hexadecimal notation) this byte is A2H.

Reading of saved measures - Request command 01H

The request of the saved measures is via the command 01H.

While the read request of the data is always managed, the sending of the saved measures can be not managed.

There are two cases in which this occurs, and for each is sent to an identification code formed by 2 bytes, of which the first corresponds to the cause of failure to execute the command and the second acts as a terminator of the message and is always 1AH:

Error codes received after the read request of the measures saved		
1st byte	**2nd byte** (terminator)	**Meaning**
00H	1AH	There are no measurements stored in memory
01H	1AH	The instrument is performing the measurements and is not able to handle the sending of the saved measures

Since the measurement data saved consist solely by alphanumeric ASCII characters, with the exception of some control characters that delimit strings or provide other information, the characters 00H, 01H, 0FH and 1AH can not be confused with alphanumeric symbols that represent the saved measurements.

Characters that the instrument sends exactly are the fields that appear in the display window of the measures saved, separated by ";", possibly, if available, with notes written by the operator.

To separate the string of a measure saved by the string of another measure saved is used the control character 1AH. Among the various strings that represent the various saved measures there are not other characters, and there are no breaks in sending the message.

If in the note written by the operator there is a carriage return this is indicated by the control character 0FH.

Here's an example of what has been explained.

```
39.7uOhm;11.5mV | 290A | 3.34W;17:54:25  10/11/14;;[1AH]
5.523mOhm;163mV | 29A | 4.9W;08:25:19  06/11/14;;[1AH]
53.7mOhm;1881mV | 3.46A | 6.50W;09:30:49  03/11/14;;[1AH]
10.13mOhm;201mV | 19.9A | 4.0W;09:29:01  03/11/14;;[1AH]
38.86uOhm;11.65mV | 299A | 3.493W;08:59:12  03/11/14;Misura di
prova sulla portata inferiore, con la risoluzione di O.O1 uOhm[0FH]
Prova eseguita in laboratorio.;[1AH]
0.038mOhm;7mV | 199A | 1.4W;08:58:44  03/11/14;;[1AH]
```

Only for reasons of greater clarity and typographical sizing you have preferred to make a carriage return at the end of each string on a saved measure and have been shown superscript control characters 0FH and 1AH only to highlight that are not part of the string, but act as respectively a carriage return inside the note and a separation between the various saved measures.

You may notice that between the data fields of a string there is the character separator ";", namely between the resistance measurement and the data voltage, current and power, and between them and the time and date. In the firsts and in last strings appear consecutively two separators ";". This is because the last field being the one dedicated to the note, if this is not present does not even have characters between the penultimate separator (after date and time) and the last separator, that would terminate the field dedicated to the note. It follows the control character 1AH that ends the string.

In the penultimate string there is a note, so after the separator ";" which closes the field regarding the time and date, follow the note that is closed from the last separator ";". As in other cases follows the character 1AH that ends the string.

There are not characters that indicate the end of transmission of the entire message.

Excluding the note, the length of which can vary from 0 to 180 characters, each string is formed by an average of 52 characters.

TEST CERTIFICATE

INSTRUMENT MODEL 20040
SERIAL NUMBER INSTRUMENT . . _____
USB PORT . . . . . OK
TEMPERATURE of CALIBRATION . . . _____

RANGE	RESISTANCE OF REFERENCE	MEASURED VALUE	PRECISION DECLARED	RESULT
1200mΩ			**2 %**	**OK**
120mΩ			**1 %**	**OK**
12mΩ			**1 %**	**OK**
1200µΩ			**1 %**	**OK**
120µΩ			**1 %**	**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 technical 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 **20024**, to which this declaration relates, is in conformity with the rules laid down in directive CEE89/336.

Cardano al Campo, 24/10/14 . *Pedranti Elio* .