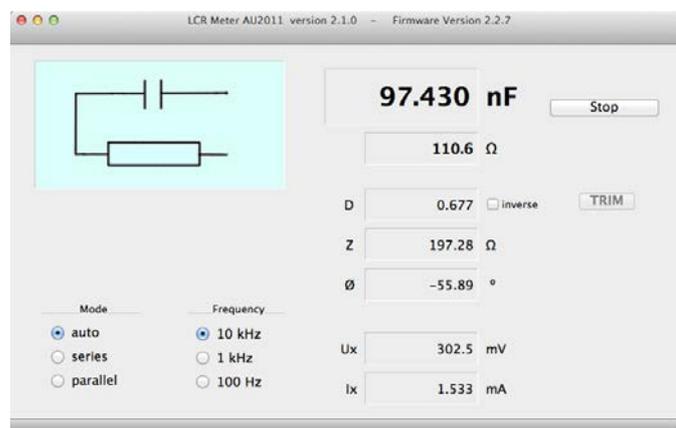
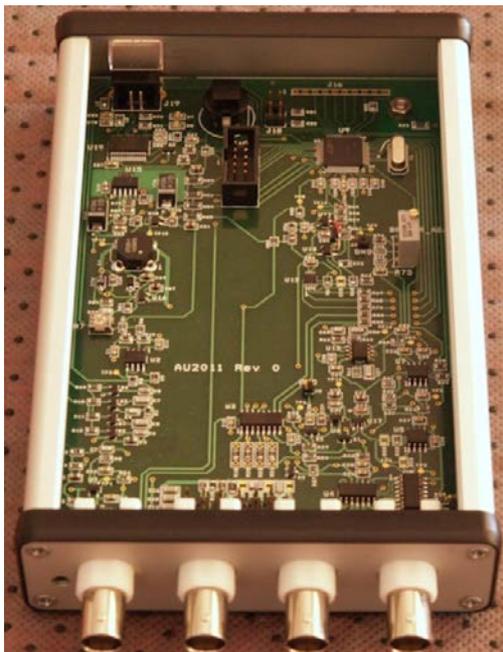


500 ppm LCR Meter (AU2011)

Elektor January – May 2013

Operating instructions

(updated: April 1 2013)



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1 GENERAL INFORMATION

The 500 ppm (AU2011) LCR meter is an automatic impedance measuring bridge. It measures resistance, capacitance, and inductance for components with impedances from 1 mΩ to 1,000 MΩ. The two guiding principles in designing this unit were maximum measuring accuracy and ease of construction.

The device can perform the measurements at 3 frequencies: 100 or 120 Hz (50 or 60 Hz power line), 1 kHz, and 10 kHz.

Two configurations are possible:

- Basic unit, with no display or keypad. Works *only when connected via USB to a computer* running the user program. This program, developed from *Qt* libraries, has been tested under *Windows XP*, *Windows 7*, *Linux (Ubuntu 11.04)*, and *MacOSX (Snow Leopard, Lion, and Mountain Lion)*.
- Basic unit + display & keypad extension. *Also works stand-alone (without a PC) with an external 5 V supply via the USB cable (which can also be connected to a computer for the power).*

Note: The adjustment procedures are described in the document ‘LCR meter | Set-up’.

2 PC mode

If the measuring head is connected to a computer via a USB link, the ‘PC’ mode is selected by default. You must use the *AU2011* program in the appropriate version for the PC operating system. The interface is in English by default, but supports translation files.

This is the only mode that allows all the device’s adjustments to be made.

2.1 Installing the USB driver

The device is fitted with the FTDI FT232R USB-UART communication IC. You must download and install the driver corresponding to the operating system running on the PC from the FTDI website (<http://www.ftdichip.com/FTDrivers.htm>).

Choose the most recent stable VCP (Virtual Com Port) version. Follow the instructions in the document ‘... *Installation guide*’ to install this driver.

Note: Under Linux, the driver is already installed in kernel version 2.6.31 or higher.

Set switch SW1 to ‘OFF’ (only the FTDI IC will be powered) and connect up the measuring head using the USB cable.

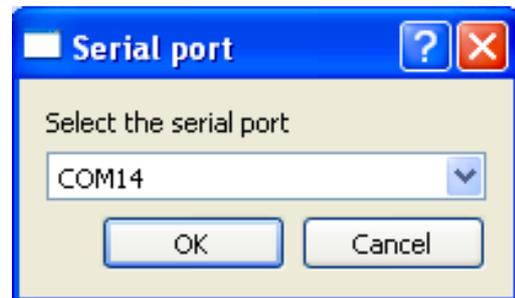
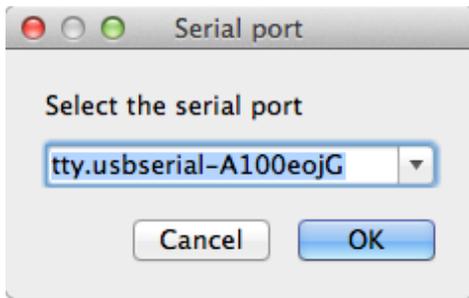
Under Windows, follow the instructions for ‘New hardware detected...’ to complete the installation of the hardware. If you have several devices connected as COMs, disconnect them to make it easier to identify the measuring head.

2.2 Running the program

Copy the folder containing the executable corresponding to your OS to the location of your choice and run it. Set switch SW1 to ‘ON’.

From the ‘Port’ menu, select the port corresponding to the device. If the corresponding drivers are detected, a list of possible names will be suggested. Under Windows it’s a

'COMxy' port; under OSX or Linux, in principle the name will contains the words 'usb' and 'tty'.



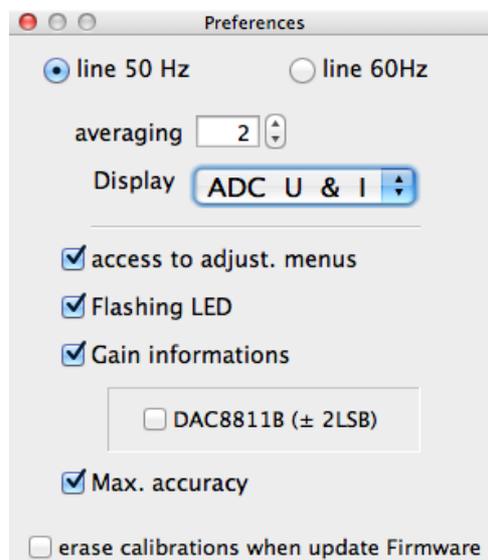
Then in the program window click the 'Open port' button. If everything is OK, you should see 'Connected to xxxxxx' displayed in the bottom strip, and 'Firmware version X.Y.Z' will be added in the window title bar; otherwise, you will get an error message. Click the 'Start' button to start the measurements.

Note: the name of the port selected is memorized. Next time you run the program, it will automatically attempt to connect to the port with this name.

2.2.1 Port menu

As seen above, this menu lets you select the serial port to be used.

2.2.2 Preferences menu



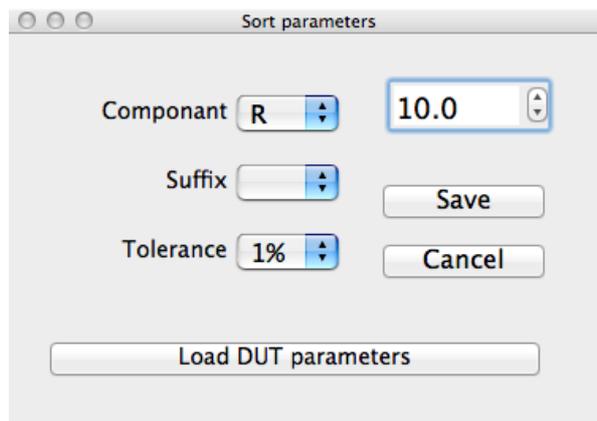
- Select your local power line frequency (50 or 60 Hz)
- Select the averaging value. This setting lets you define the number of measurements that will be used to calculate an average value so as to limit fluctuations in the value being measured. It has a direct influence on the measurement time. A value of 1 corresponds approximately to two measurements a second.
- Dropdown menu for selecting the parameters that will be displayed below the phase.
- Four checkboxes for the display choices.

- **access to adjust. menus:** check to access the menus that let you perform the adjustments the first time the device is brought into service. These are saved into the device's EEPROM memory. **This choice is not memorized**, as it is used only for the adjustments.
- **Flashing LED:** a small LED can be displayed to the left of the display field for the dominant parameter, which flashes in time with the measurement results display.
- **Gain informations:** lets you display information about the gain ranges, the actual frequency at the measuring head, the maximum measurement error introduced by the differential errors between the measurement chain gains during the U and I measurements. If the IC used for the multiplying DAC is a DAC8811B (accuracy ± 2 LSB) instead of a DAC8811C (accuracy ± 1 LSB), you must check the *DAC8811B* box so the error is calculated correctly.
- **Max. accuracy:** The values measured are displayed with maximum precision. If the **Max. accuracy** option is unchecked, the LSB figure is not displayed, which conceals certain fluctuations!
- A box to check if you want the calibration information (resistor values, phase corrections, offset settings) stored in the microcontroller's EEPROM to be erased when the firmware is updated. In this case, don't forget to make a note of the resistor values! **This choice is not memorized.**

2.2.3 Tools menu

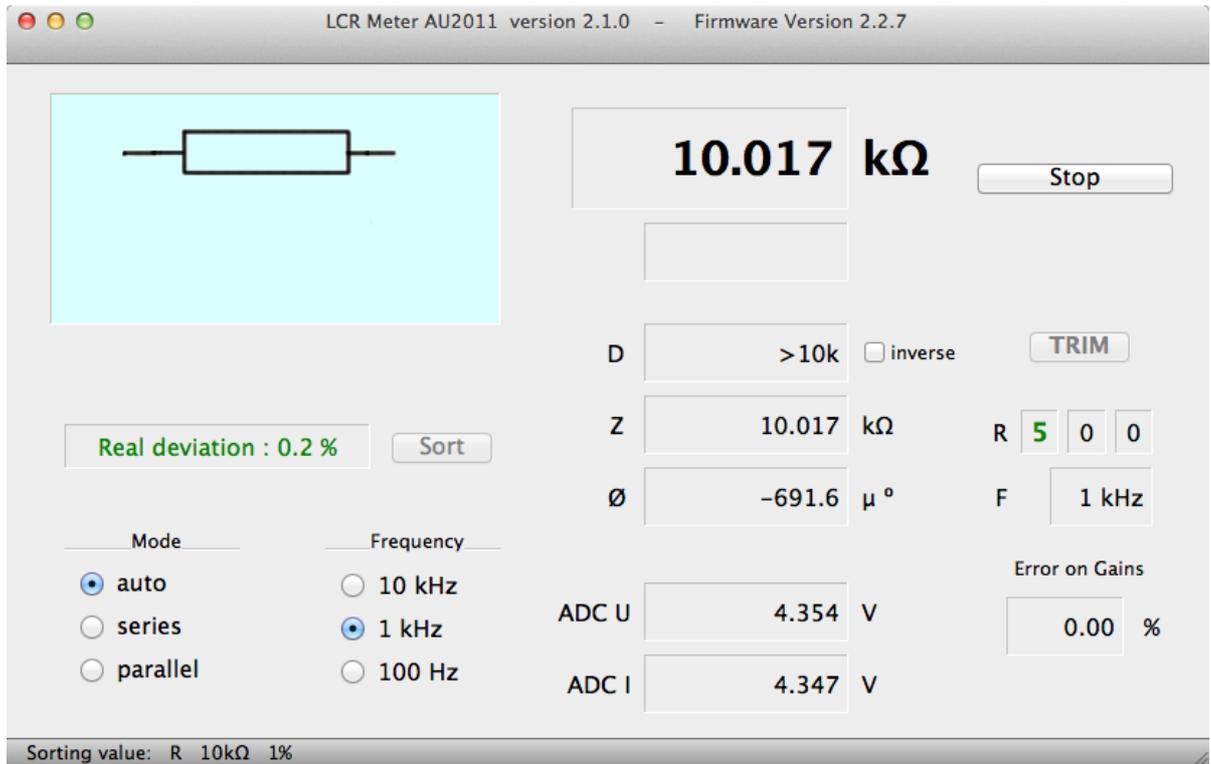
- If the 'Access to adjust. menus' box under the Preferences menu is checked, the sub-menu allowing you to carry out the various calibrations and settings are enabled. Follow the instructions.
- **Update program...:** starts the procedure to update the firmware. The update file *LCR3A_firmware_Vxxx.hex* is a text file in Intel HEX format.

2.2.4 Sorting menu



- **Sort parameters:** opens a window that lets you select the reference component type (C L R), its value, and the sort tolerance. Click the *Load DUT parameters* button, then adjust these to the desired values.
- **Enable sorting:** displays a button in the main window, which you just have to click to run the sort procedure between the component being measured and the reference values (which are shown in the bottom strip – see below).

2.3 User Interface



The program's main window displays the measurement results, and a number of buttons let you modify certain parameters or initiate certain actions.

A pictogram shows the equivalent circuit of the component under test.

When the mouse pointer passes over a display field, a bubble appears giving information about what is displayed in this field.

2.3.1 'Open port' button

Starts the procedure for connecting to the serial port defined (and memorized) in Preferences. If the connection has already been established, the button is disabled.

Note: If it has been possible to establish the connection automatically at start-up, this button won't appear at all.

2.3.2 Stop / Start button

As its name indicates, stops or starts the measurements.

2.3.3 TRIM button

Runs the OPEN / SHORT compensation.

If the impedance module connected *at the moment of testing* is:

- $< 10 \Omega$, the *SHORT* compensation is run.
- $> 100 \text{ k}\Omega$, the *OPEN* compensation is run.

Compensations are performed for each frequency. In the event of an error, the value is not used.

Attention: Only start this operation with an actual short-circuit or open circuit, otherwise the values adopted for the compensation will not correspond with the intended aim, which is to compensate only the stray elements of the measuring device!

Note: A red symbol appears below the equivalent circuit window to indicate any compensation that has not been carried out (the first time the unit is brought into service, or when the measuring head firmware is updated).

2.3.4 Sort button

This button only appears if the *Sorting / Sort parameters* menu is checked. Click this button to start the sorting procedure. The display appears momentarily in a field to the left of the button; the real deviation is displayed in green if it is within the tolerances, or in red if outside.

2.3.5 Mode

Select the mode for representing the component under test:

- *auto*: selection between series or parallel is performed automatically depending on the impedance of the component under test.
- *series*: forces series representation.
- *parallel*: forces parallel representation.

2.3.6 Frequency

Select the test frequency. The lowest frequency is twice the line frequency, selected in Preferences.

2.3.7 Gain

Only visible if the box is checked under Preferences. The first field indicates the measuring range:

- in green for ranges 3–6 where the error due to the main amplifier is zero.
- in magenta for ranges 2 and 7 (error due to the main amplifier $\pm 0.02\%$).
- in red for ranges 1 and 8 (error due to the main amplifier $\pm 0.04\%$).

The other two fields give the values, between 0 and F, of the steps of the multiplying DAC for the voltage and current measurements.

If the *Max* check box is visible, the gain error value is calculated using typical values or using the *Max* value (for the PGA103), depending on whether or not it is checked.

2.4 Settings menus

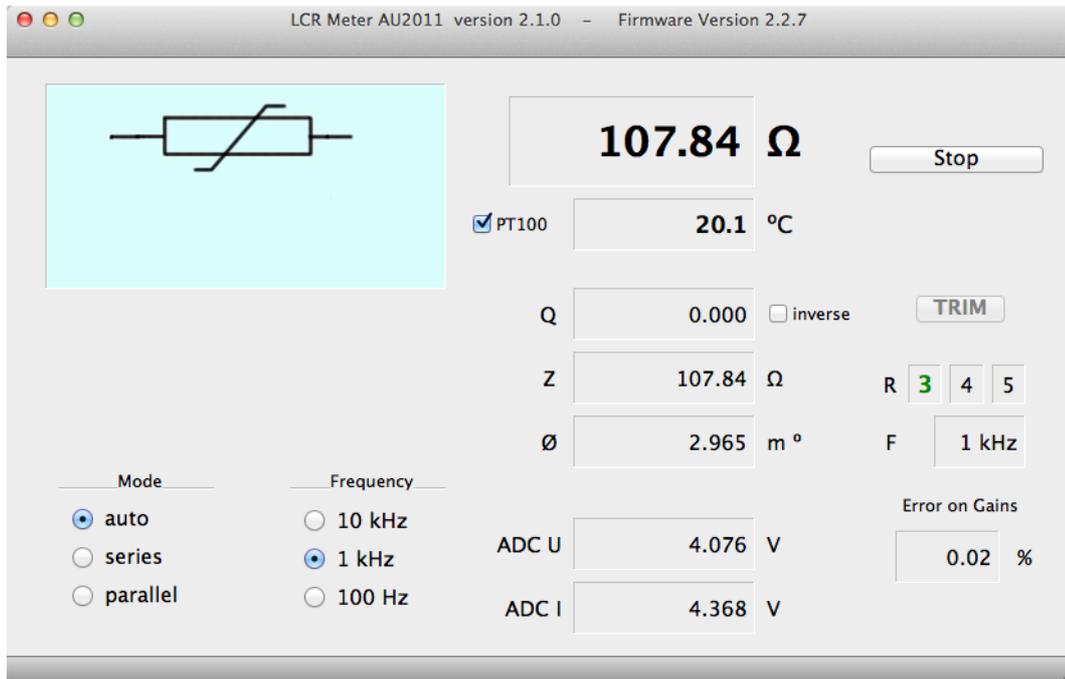
These menus let you perform a number of internal settings: offsets, calibrations, etc. The first three don't require you to take the top cover off.

Please refer to the document [LCR meter | Set-up](#).

2.5 Measuring a PT100 platinum probe

When the value of a resistor lies between $70\ \Omega$ and $300\ \Omega$, the frequency is $\leq 1\ \text{kHz}$, and the Q (quality factor) is practically zero, a box marked PT100 appears to the left of the secondary parameter display field. By checking this, the temperature value is shown for a PT100 platinum probe with this resistance. The symbol changes to that of a thermistor.

The measuring range goes from $-75\ ^\circ\text{C}$ to $+557\ ^\circ\text{C}$, with a resistance/temperature conversion accuracy exceeding $0.05\ ^\circ\text{C}$.



Important note:

When the unit is powered up, the bootloader takes charge and checks that the memory occupied by the firmware is not corrupted. If it is OK, the bootloader hands over to the firmware, which waits for the *AU2011* program to be connected (opening the port, etc.). If not, the bootloader keeps control and as soon as the *AU2011* program is connected, sends a firmware update request.

It can happen that firmware is loaded into the memory with bugs, **which will prevent any future updates!** To be able to get out of this apparent impasse, you have to power down the unit, fit a jumper to J17 (accessible by removing the rear panel) and reboot. The bootloader detects the presence of the jumper on J17 and interprets it as an *unconditional* update request.

3 Standalone mode

If the device is fitted with the *display & keypad* extension, it is able to operate independently, without needing a computer. In this mode, it starts automatically when using an external 5 V USB power supply. However, if it is being powered from a PC, but you still want to use it in standalone mode, you'll need to press and hold any button on the keypad before powering it up using SW1.

*In this mode, it is not possible to perform adjustments.
All the legends are displayed in English.*



3.1 Keypad

The **keypad** lets you select the device functions and to configure certain parameters. The keys have different functions depending on whether you press them quickly, or hold them in for more than two seconds (indicated by the green LED).

- The primary functions are in black.
- The secondary functions (long press) are in blue.

In the menus, the function of the keys is indicated at the bottom of the screen.

3.2 Primary functions

3.2.1 S/P/A

This key lets you choose the model between series or parallel equivalent circuits for calculating the parameters, or the automatic model mode. In the latter case, the instrument determines the model that is most usually appropriate:

- series model if the modulus of the impedance $|Z|$ is $\leq 1,000 \Omega$
- parallel model if the modulus of the impedance $|Z|$ is $> 1,000 \Omega$

3.2.2 Param.

This key sequentially selects the parameters displayed:

- Displays the modulus of the impedance $|Z|$ and the phase angle Φ .
- Displays the equivalent series resistance R_s and equivalent series reactance X_s .
- Displays the component's rms voltage V_x and rms current I_x .

The last parameter selected is saved.

3.2.3 Freq- & Freq+

These keys let you change the measurement frequency. The last frequency selected is saved.

3.3 Secondary functions

3.3.1 Menus

Hold this key pressed in to go into *Menu* mode.

3.3.2 Q_D

Pressing this key for > 2 secs. reverses the automatic display of $Q \rightarrow D$ or $D \rightarrow Q$, i.e. the display of the **Quality** factor to the **Dissipation** factor and vice versa.

3.3.3 Sorting

You first have to define the sort parameters via the *Sorting Parameters* menu. To keep it short, all the legends here are in English.

Holding this key in lets you enable (message Sorting is ON) or disable (message Sorting is OFF) the **Sort** mode.

The value of the component being sorted is displayed with its symbol.

The sort parameters are displayed in reverse order.

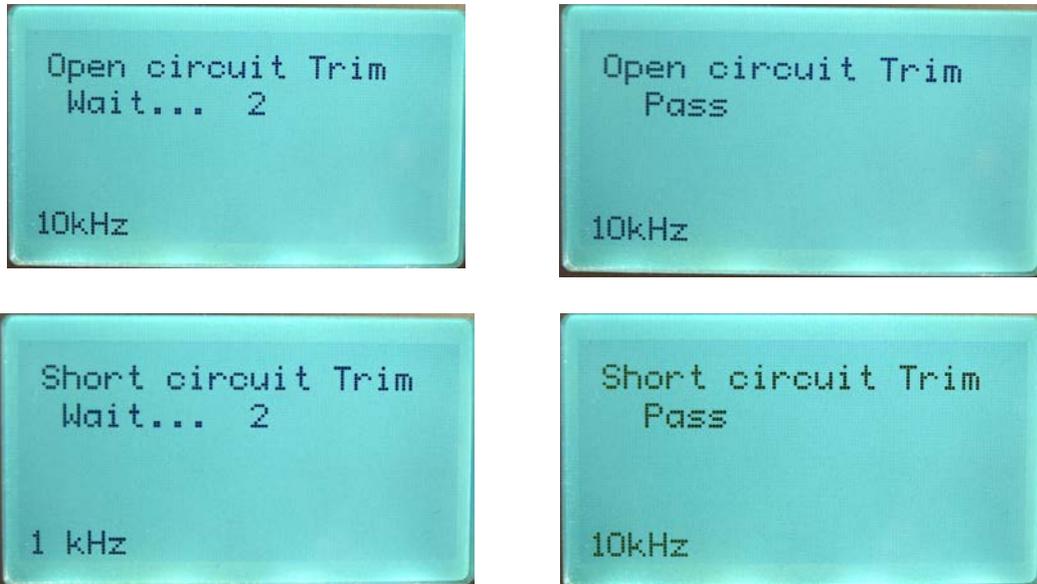
Pressing the [GO] key starts the comparison, with momentary display of the actual tolerance and the result (OK or BAD!)



3.3.4 Trim

Pressing and holding this key lets you run the OPEN / SHORT compensation. Compensations are performed for each frequency.

- If $|Z|$ is $< 10 \Omega$, the SHORT calibration is performed.
- If $|Z|$ is $> 100 \text{ k}\Omega$, the OPEN calibration is performed.



In the event of an error, the value is not used.
 If either or both of the calibrations are invalid, a flashing symbol appears in front of the primary parameter value. Re-do the incorrect calibration(s).



3.3.5 Unlabeled button

See section 3.5

3.4 Menus

Navigation is performed using the \uparrow and \downarrow keys.
 The $>$ symbol indicates which menu will be selected by [ok].
 Pressing the [eX] (exit) key takes you out of *menu* mode.



3.4.1 Sorting Parameters

This menu lets you select the parameters (tolerance and value) used for sorting components. The value proposed will be that of the primary parameter of the reference component connected before going into menu mode. These parameters will be memorized.

The first step lets you select the tolerance using the [-] and [+] keys, then confirming with [ok].



The next step lets you adjust the value that will be used as the sort value, starting off from the primary parameter of the component connected.

[-] and [+] keys, confirmed with [ok].



3.4.2 Averaging

This menu lets you define the number of measurements that will be used to calculate an average value so as to reduce the fluctuations in the value being measured.

Set between 1 and 9 using the [-] and [+] keys, confirm with [ok].

The default value is 2.

Attention: the duration between measurements is proportional to this setting; in normal use, we recommend using a value of 1 (2 measurements per second) or 2 (1 measurement per second).



3.4.3 Display Range OFF (ON)

This menu lets you enable (*Display Range ON*) or disable (*Display Range OFF*) the display of the current *range* and the multiplying DAC steps for the *voltage* and *current* measurements. The default value is *OFF*.

3.4.4 Adjust Contrast

This menu lets you adjust the display contrast.

Set between 1 and 16 using the [-] and [+] keys, confirm with [ok].

The default value is 5.



3.4.5 Back Light OFF (ON)

This menu lets you enable or disable the display backlight.

The default value is *ON*.

3.4.6 Line freq. 60 Hz (50 Hz)

This menu lets you define the line frequency.

The default value is 50 Hz.

3.5 Measuring a PT100 platinum probe

When the value of a resistor lies between 70 Ω and 300 Ω , the frequency is ≤ 1 kHz, and the Q (quality factor) is practically zero, it is possible to display the temperature value of a PT100 platinum probe with this resistance.

To do this, press and hold the unlabeled key K4, which is used to confirm [ok] in the menus; the component symbol becomes that of a thermistor. Pressing and holding K4 again lets you return to the standard display. The status of this key is not saved.

The measuring range goes from -75 $^{\circ}\text{C}$ to $+557$ $^{\circ}\text{C}$, with a resistance/temperature conversion accuracy exceeding 0.05 $^{\circ}\text{C}$.