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User manual hygrometer LB -797

Version ¹ 1.6 October 2012
from the firmware version 3R0
LB79x program version 1.05



¹ *Continuous development of our products causes sometimes need to make changes that are not described in this manual*

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1. Description hygrometer

LB -797 materials hygrometer is designed to measure soil moisture and other bulk materials with a grain diameter up to several millimeters. You can save to the memory the characteristics of the materials of any user (up to 50 characteristics) using the LB79x. Calibration of the meter for the new material may be performed by an User or the LAB- EL lab after delivery of material samples.

The operating principle of hygrometer is based on the measurement of dielectric constant of material by a capacitive method. Two needle electrode, with which the probe is equipped, should be placed in the measured material. The dielectric constant of a dry material such as sand is about 4, while the dielectric constant of water is 80. Wet sand has intermediate dielectric constant values – on this basis the moisture is calculated. Moisture is measured four parameters of the soil:

- humidity,
- temperature
- conductivity,
- dielectric constant.

The probe LB -797 is available in two versions:

- LB- 797A - with handle,
- LB- 797C - without handle - designed to be buried in the soil.

The probe LB -797 is not a stand-alone device and to read the results of measurements the reading panel LB- 796 is required. In addition, the probe is equipped with the following interfaces:

- Interface S300 - two-wire transmission over long distances,
- Output voltage 0.. 10V
- Modbus-RTU (EIA-232 or EIA-485) with 8-channel concentrator LB-473,
- Ethernet - by 4-channel data acquisition LB-489 or 8-channel LB-487.

The probe also works with a meteorological station LB-741. Read the measurement is also possible with a computer by using a S300/USB – LB-375 converter and the LBX software.

Additional equipment:

- Drill to the soil,
- Tube for introducing the probe into the hole in the soil – for LB- 797C.

The main characteristics of hygrometer LB- 796P + LB -797 set are as follows:

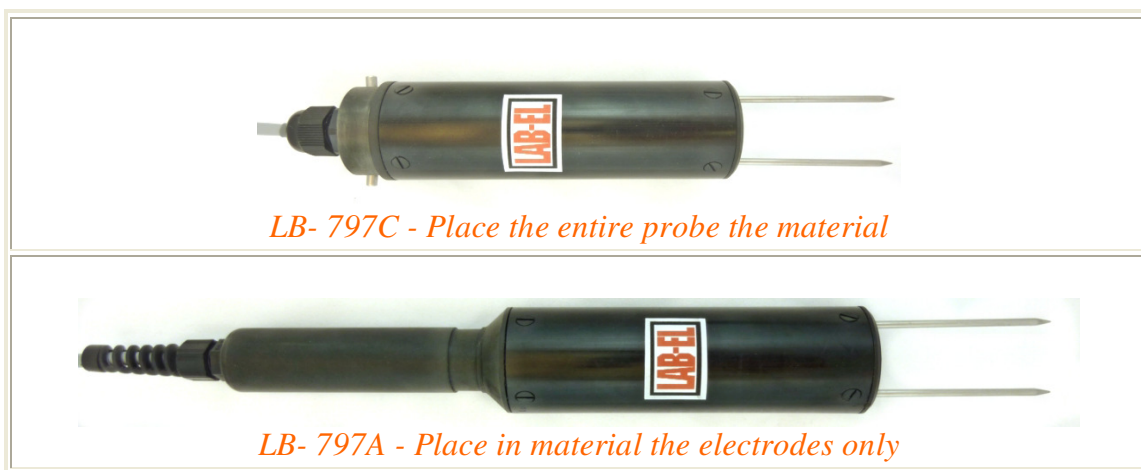
- easy to read LCD display, energy-efficient measuring microprocessor
- meter, that can be calibrated for any material supplied by the user to the lab - the calibration parameters are stored in non-volatile memory of the meter (it is possible to store up to 50 types of materials),
- temperature sensor with built-in meter in the range of -20...70°C, it is also possible temperature measurement using the optional external sensor TL- 2\ 796 \ DB9, which is connected to the panel LB- 796,
- battery powered,

- measuring the dielectric constant of the material,
- ability to measure the conductivity of the material,
- sound signaling of humidity level after crossing preset humidity threshold
- hygrometer switch off automatically after 3 minutes of inactivity,
- signaling of the measuring range crossing,
- remembering of the last selected material,
- short circuit signaling of the meter electrodes - this way we obtain an unambiguous measurement of humidity,
- low battery indication,
- auto-zero function when you turn on the meter, it is possible to reset the request.

1.1 Elements of the hygrometer

Location of elements on the LB- 796P panel, which are accessible for the user, is presented one the Figure 1.

- A - 3.5 digit LCD display,
- B – keyboard,
- C – multifunction socket for connecting:
 - hygrometer LB -797,
 - external thermometer TL-2/796/DB9,



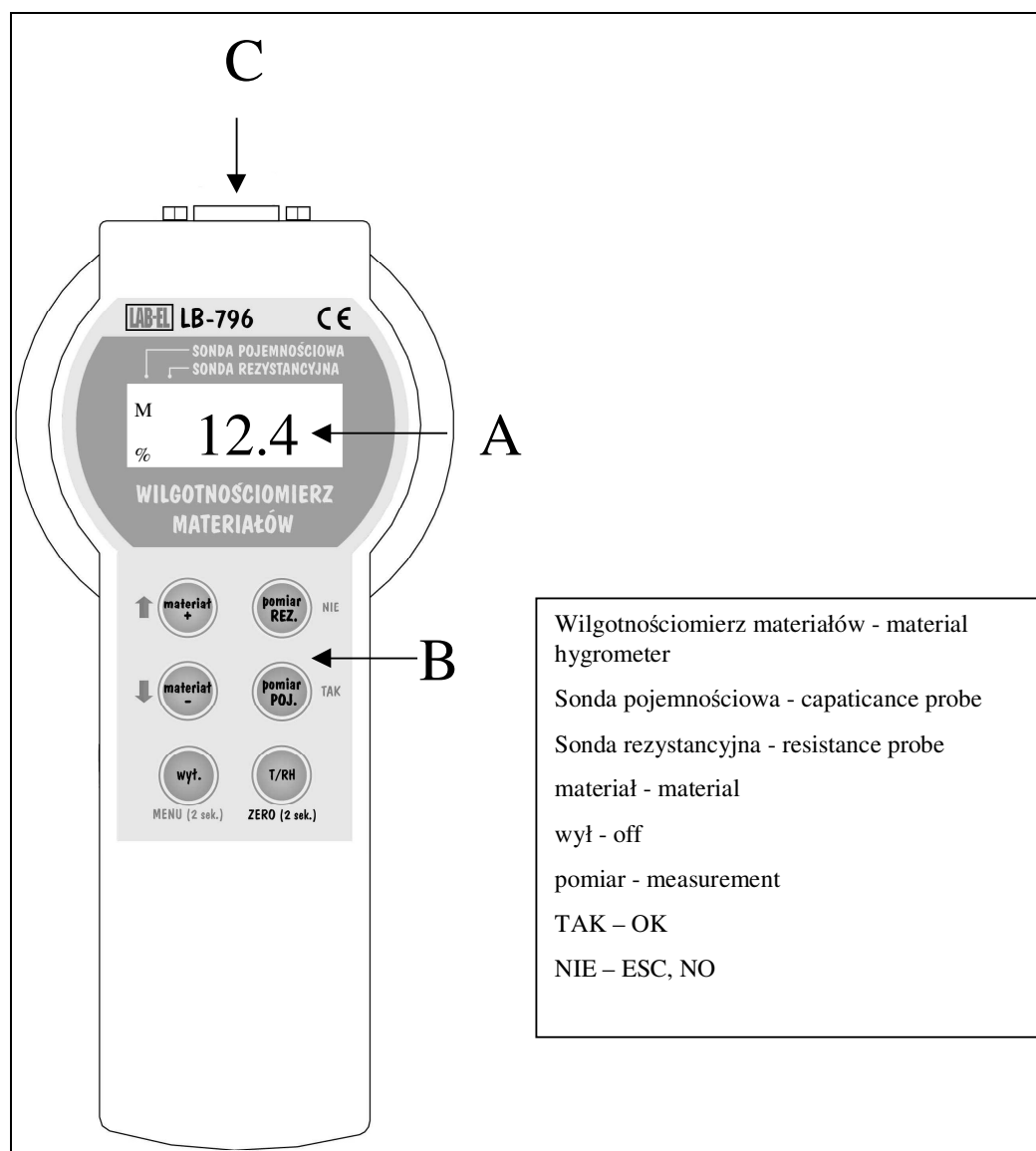


Figure 1 Panel LB-796P – view from the keyboard

From the bottom there is an access to the battery.



The hygrometer set includes:

- hygrometer LB -797,
- reading panel LB- 796P (or LB- 796A) - optional,
- converter LB -375 - an option together with the program LBX,
- converter LB – 376C - optional with the program LB79x,
- communication cable LB- 79XRS with power supply - as an option together with the LB79x calibration program.
- drill to the soil - optional,
- pipe for guiding the probe LB - 797C in a hole in the ground - optional.

1.2 Start of a measurement – short description

This chapter presents a short description of the material moisture measurement, the conductivity of the material and the temperature of the material. More details regarding the operation of the meter is presented in the Chapter 2, you should be aware of them.

To measure the moisture content one should perform the following activities:

- connect hygrometer LB -797 and reading panel LB-796 (to the socket labeled as C on Figure 1), attach it to the socket with the screws included in the probe plug
- press any button to turn the meter on except the "wył" (off) button. - wait for the appearance of the "797" inscription and press the "Pomiar POJ" (moisture measurement) button,
- the display will show the "CAL" inscription, which indicates auto-zeroing of the meter and then the symbol of recently selected material, the symbol  shown on the screen will inform, that the moisture measurement mode is on.
- choose the right material by pressing the "material+" or "material-" (material+ or material-), the a three-character code will be displayed. The list of materials and the corresponding codes are stored in the meter memory, they can be found in an **additional annex** to the manual,
- Press the "Pomiar POJ" (moisture measurement) button again - the character % with the measurement of humidity will be displayed on the screen,
- put the meter electrodes in the measured material and read the measured result of humidity (**electrodes should be completely immersed in the measured material for the probe LB- 797A, for the probe LB- 797C the entire probe should be submerged in the material**). The electrodes should not be driven into the hard materials - it can lead to the damage of the probe,
- If the measurement result is blinking, it means exceeding the measuring range,
- when you press the "Pomiar REZ." (resistance measurement) button, the conductivity of the material will be displayed in mS / m (miliSimens / meter) - about the resistance measurement activity will inform you the symbol  on the screen,
- after pressing the "T/TH" button the temperature of the material will be displayed, the active temperature mode will be indicated by temperature symbol ° C.

2. Operation of the hygrometer

2.1 Switching on and off

Before switching on the device should be connected to the reading panel LB- 796 and to the LB -797 probe (to the socket labeled as C in Figure 1).

Turning the panel on may be done with any button other than the "wył" (off) button, which is for the switching off. After you turn the display moisture meter on, for a moment internal firmware version of panel LB- 796 will display with a single letter version of the meter, for example:

2.2P

and then the firmware version of the connected probe will be for example:

1.2

and after a moment the symbol of connected probe:

797

While viewing these inscriptions an initial testing of the instrument is carried out. The meter is equipped with **auto off function** - it activates after 3 minutes after the last pressing of any key on the keyboard, and when the result of the humidity measurement has not changed in that time by more than 10% of the measuring range (auto off will switch off after 10 minutes regardless of this condition). If the hygrometer does not react for attempt to switch off with the keyboard, remove the batteries and re-insert them back.

2.2 Description of the keyboard

The reading panel LB- 796 is equipped with a 6- button keypad. There are two modes of operation:

- measurement mode - button functions are described in black,
- menu mode - button functions are described in blue (see *Menu Mode*).

In the measurement mode buttons have the following meanings

- Pomiar POJ. - Starts measuring humidity
- Pomiar REZ. - Starts measuring the conductivity,
- T/RH - starts measuring temperature,
- materiał+ - material selection (scroll forward by one material)
- materiał- - material selection (scroll back by one material)
- wyłącz. - turns off the device.

2.3 Menu mode

From version 2.0 software, the meter is equipped with a 6 press button keyboard with the menu mode. Button functions in the menu mode are marked **in blue**:

- MENU (2sek.) - to start the menu mode, you may press it and hold for 2 seconds until the menu mode starts, release of the button earlier than 2 seconds will turn off the meter (the function of this button is shared with a button, which turns off the meter).
- ↑ up arrow is used to select menu options or to set various parameters in the menu (increasing parameter)
- ↓ down arrow is used to select menu options, or to set various parameters in the menu (decreasing parameter)
- TAK (YES) - enter the selected menu item or approval of an adjustable parameter in menu,

- NIE (NO) - exit from the menu (or go up one level in the menu).

2.3.1 Menu options

- **bu** - threshold activation for audible signals
- **Pro** - calibration mode, selecting this mode will input in calibration mode (you cannot exit this mode by pressing the "NIE" (NO) button - you have to turn off the meter).
- **nr** - (no) displays serial number of probe LB -797.


2.4 Measurement of humidity and conductivity of the material

2.4.1 Measurement of material moisture

Material moisture measurement should be carried out as follows:

- connect hygrometer LB -797 and LB- reading panel 796 (to the socket labeled C in Figure 1), attached to the socket with the screws included in the plug probe,
- after turning the hygrometer display, when the 797 inscription shows, press "Pomiar POJ" button - Display will briefly read for a moment:



indicating the auto-zeroing of capacitance probe (**at the time do not touch the probe electrode**) and the symbol for the last selected material will show. The displayed symbol , informs that an activity of humidity measurement mode is on.

- by pressing the "material+" button or "material+" button - select the material code, which moisture has to be measured. This code will show up on the display. The list of available materials and corresponding codes may be found in **an additional annex** to the manual,
- Press the "Pomiar POJ" button again - the character % will show on the display with some humidity measurement result (lower measurement range),
- put the meter electrodes in the measured material (see the chapter *How to place electrodes in the material*), and read the result of humidity measurement (**electrodes should be completely immersed in the measured material for the LB- 797A probe, a for the LB- 797C probe the entire probe should be submerged in the material**) the electrodes should not be hammered hard into materials - it can lead to irreparable damage of the probe, the probe should also be protected against falling, which can cause breakage of electrodes.
- If the measurement result is blinking, it means exceeding the measuring range,
- when the display shows alternately with the measurement of humidity message like this:



it indicates a short circuit of the electrode probe (too high conductivity of the material caused by salinity), you should be aware, that in this situation the measurement result is erroneous.

- during the measurement of the moisture flashes ° C, this means that the active temperature compensation for material moisture is on.
- it is possible to set the moisture threshold, from which the system beeps (see chapter *Sound signal of the moisture level*).

2.4.2 Conductivity measurement of the material

Conductivity measurement of the material should be carried out as follows:

- connect hygrometer LB -797 and LB- reading panel 796 (to the socket labeled C in Figure 1), attached to the socket with the screws included in the plug probe,
- after turning the hygrometer on, when the display will show **797** inscription press Pomiar REZ button. - the display will read for a moment:



indicating the auto-zeroing capacitance probe (**do not touch at the time the probe electrode**) and then some conductivity measurement result in mS / m (miliSimens / meter) will display,

- put the meter electrodes in the measured material (see the chapter *How to place electrodes in the material*), and read the result of conductivity measurement (**electrodes should be completely immersed in the measured material for the LB- 797A probe**) the electrodes should not be hammered hard into materials - it can lead to **irreparable** damage of the probe, the probe should also be protected against falling, which can cause breakage of electrodes.
- when the display shows alternately with the measurement of conductivity message like this:



this means that the probe electrodes short circuit (too high a conductivity of the material caused by salinity).

- conductivity of the material should not be confused with the conductivity of water in the material.

2.4.3 The method for placing the electrodes in the material

The method of electrodes placing in the material has a decisive influence on the accuracy of the measurement of humidity and conductivity of the material. First of all, **the electrodes should be placed entirely in the measured material for the LB- 797A probe and for the LB- 797C probe the entire probe should be submerged in the material.** There are two ways to place the electrodes in the material:

- with manual compaction of the material,
- without compaction.

It is important that the material does not create air bubbles that cause a downward deviation of the measurement result. Generally, the electrode should be placed in the material initially compacted by hand, unless the material is in the form of defined pellets and does not form air bubbles - in this situation the electrode can be placed without initial compacting of the material. Initial compaction of the material should be performed for the following materials: **sand, soil, coal dust, copper sulphate.**

Additional remarks, which are applicable during the measurement:

- during the humidity measurement (conductivity) one should select the sample of the material for the measurement to be hygro representative of the entire sample, or it is necessary to perform several measurements and average them,
- after the measurement the probe should be washed, especially the electrodes need to be cleaned.
- **All metal parts located near the probe electrodes disturb the measurement (result increasement),** especially one should not measure humidity in metal containers (unless they are sufficiently large).

2.5 Temperature measurement of the material

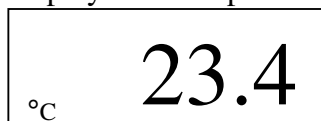
The probe LB -797 has a built-in thermistor temperature sensor, which is located in the cap between the measuring electrodes. You can also purchase TL-2/796/DB9 external temperature sensor connected to the LB- 796 panel.

Temperature measurement of the material should be carried out as follows:

- connect hygrometer LB -797 and reading panel LB-796 (to the socket labeled C in Figure 1), attach it to the socket with the screws included in the plug probe,
- after switching the hygrometer on, when the **797** shows up, press T/TH, the display will briefly read:



indicating the auto-zeroing of the capacitance probe (do not touch at the time the probe electrode). Then the symbol °C and temperature measurement results display for example:



- place the probe in the measured material, wait for the temperature to stabilize and read the temperature result,
- If the measurement result is blinking it means exceeding the measuring range.

2.6 Audible signal of the humidity level

The meter can be set for the humidity threshold alarm sounds. The default threshold is 50 %, if you need a different threshold it can be set in the range 0..199.5 % in increments of 0.5 %. This may be done in the following way:

- start the menu mode and select the **bu** menu option,

- confirm the setting with "TAK" (YES) button, the display shows the currently set threshold humidity, by which the sound signal is activated,
- Now you can change the threshold value by using the arrow keys ↑ ↓,
- after setting the appropriate threshold it should be confirmed by pressing YES button, the approval will be signaled acoustically and you exit to the one level above,
- you exit the menu mode by using the NIE (NO) button,
- by approaching the hand to the probe electrode you can check whether a beep is generated when the set threshold is exceeded.

2.7 Calibration of the meter for the new materials

In the case of humidity measurement of materials, which are not present on the list of materials for in the additional annex, an interpretation of the result depends on the User. The relations between the measurements are preserved i.e. when the indicated result on the first sample is smaller than the result indicated on the second sample, then the first sample is more dry than the second sample.

To properly calibrate the moisture meter to indicate the result, for example % of the mass humidity, one should supply the samples to the LAB-EL laboratory (or information about the material production methods) to calibrate the meter for a new material. Guidelines for the preparation of specimens are as follows:


- the material sample should have a maximum expected moisture (if you cannot soak the material and the water content in the material results from manufacturing processes), and it should be enclosed in a sealed package,
- in the case of materials that can be soaked in, a sample should be in absolutely dry state, also it should be sealed,

Calibration of the meter for the new material can also be performed by the User. You need for this the LB79x calibration program and appropriate instrumentation (scales, drier) or have another standard meter to measure the moisture content of the material.

In the following part of the manual there is described how to calibrate the LB-797 probe in order to adapt it to measure the humidity of new materials and the procedure for writing in the characteristics of the materials to the memory using the LB79x software. Prior to calibration, refer to the operating instructions describing the measurement of moisture in order to properly perform calibration measurements.

2.7.1 Entering the calibration mode

Entering the calibration is done by selecting the appropriate menu option (see Menu Mode). It is necessary therefore:

- run menu mode and select the menu option **Pro**
- press the "TAK" (YES) button to confirm the selection, you will go to the calibration mode,
- calibration mode is indicated by the flashing sign, ,
- when the meter is in calibration mode press T/RH to start temperature measurement,

- exit the calibration mode is performed **only** by pressing the "wył" (off) hygrometer button..

In the calibration mode, the display shows the value of the parameter that will be measured during the calibration measurements. This parameter should be interpreted as the square root of the dielectric constant of material (referred to as **sqrteps**), **the measurement should be made keeping all the tips that are given for the measurement of moisture (especially for placing the electrodes in the material).**

2.7.2 Performance of calibration measurements

Meter calibration for the new material is based on performance of the parameter measurement with the LB-797 meter (in the calibration mode) and the measurement of moisture material with the other device, which is considered by the User as a model device (for example by the drying-weighing method according to the *PN-EN ISO 12570 standard* – for construction materials and products , *PN-ISO 11465 or PN-ISO 11461* for soil, or with any other standard meter) for at least two different moisture material measurements, which would create a measurement range. Ideally, the humidity measured values are separated, i.e. once the material, which is considered to be almost dry, is measured, then we measure the material, which is considered as a wet one. The calibration results consists of a table with moisture material values and material parameter values, as it is presented in the Table 1.

Humidity [%]	SqrtEps
0	2.32
10.8	3.42
18.1	4.03
25.3	4.84
33.6	5.45

Table 1 Sample calibration table for the new material

The greater the number of measurement points , the better the later accuracy. The calibration should be performed for the material temperature as close as possible to 20 degrees because of the correctness of automatic temperature compensation .

The measurement of parameter with averaging is recommended , i.e. for a specific material moisture the several measurements should be performed and the average calculated.

If measurements are made using **drying-weighing method**, the best way would be to dry material completely (0 % humidity) to measure the value of the parameter sqrteps for dry material (the first calibration point) and then gradually add water while stirring the material - this way new calibration points will be created up to full saturation of the material with water.

2.7.3 Processing of measurement results

After the calibration measurements there should be drawn characteristics of the material i.e. the function of humidity (parameter), for example in Excel. This function should be increasing . In general, the large part of it should be a straight line, with the

curvature on the endings for the measuring ranges (for small and large humidities) may be higher. The shape should be visually assessed and, for example, the measures, which indicate their error during measurement, reject (or if the data points are more than 15). You may calculate the approximating function by, for example, polynomials and with its help generate points evenly to write to the device. An extrapolation of characteristics is acceptable when at the end of the range there is a clear saturation (fold of the line) but during the extrapolation, it should be taken into account that the range of the parameter is:

- **sqrteps - 1.0...10.0** - when parameter increases, the humidity increases too. In general extrapolation (extending beyond the measured characteristics of humidity) should be made so that the end of the measuring range for the characteristic values would be equal to the characteristic values, for example, for 100 % humidity.

2.7.4 Entering the characteristics of the material to the meter memory – operation of the LB79x software

Using the LB79x calibration software enter the characteristics of the material to the memory of the meter. To do this, perform the following steps while **maintaining the specified order**:

- install LB79x software (if it was not already installed)
 - run the software installer located on the CD, which is supplied with the device and sequentially perform the installer instructions,
 - if the installation program started automatically, turn it off.
- LB -797 connection to the computer (the LB79x software should be off):
 - when the **LB- 79xRS communication cable** is included to the set - connect the cable to the LB-797 probe, on the other side of the computer (COM port), turn on power supply to the grid,
 - when the **LB- 376C converter** is included to the set - connect the converter to the meter LB-797 on the other hand to the computer (USB port) using the USB cable that is supplied with the converter set,
 - after connection of the LB- 376c to the computer, the operating system should detect and automatically install the appropriate drivers for the converter - the correct operation of the LB- 376c converter will be indicated by a **red LED (PWR) on**,
 - if for some reason the system does not recognize the correct converter LB-376c, the proper driver should be installed manually. The driver is located in the USB directory of LB79x software (typically this is C:\ Program Files \ LB79x \ USB). To do this, use the Windows Device Manager to find improperly installed the USB device and update the driver by indicating the position previously described.
 - the above described configuration of LB-376c converter should be done only once on the first use - every the next connection of the converter (to the same USB port) should be

automatically detected by the operating system without any messages from of the operating system.

- start the LB79x software and select:
 - COM port number (menu *Settings- serial port*), to which the meter will be connected to,
 - for the LB- 376c converter the port will be named (*USB Serial Port*)
 - the LB79x program stores the original settings of the port and if the device is connected to the same port as before, you may skip this step.
- in the window of the LB79x program the temperature display should show up - it proves the correctness of communication processes. When working with LB79x do not disconnect the LB -797 probe from the computer - it may lead to the loss of materials characteristics, which are recorded in the meter. The meter can be disconnected from the computer after turning off the LB79x program .



Figure 2 Sample window of the LB79X software after connecting the probe LB -797



Figure 3 Figure LB - 376c converter - to be connected to the probe to the computer via the USB interface

From the Panel menu, select the submenu "*Charakterystyki Materiałów*" (Characteristics of Materials), all the characteristics of the material will be read, you should select a free characteristics record by a double clicking and fill the following fields of the characteristics record:

- activate the characteristics record (mark an appropriate box),
- select **the appropriate method of measurement** – (capacitance),
- activate (or not) **temperature compensation** - it is recommended to activate the compensation, especially when the water volume is more than 10 % of the sample material,
- enter a three characters **material code**, the shown digits are 0...9, letters: **A, B, C, D, E, F, G, H, I, L, N, O, P, R, T, U, U, Y, V, J, a space**, when other letter is used the minus sign will be displayed; **unacceptable codes: Er0...Er9, bAt OFF, ERL, CAL**. The code will be **displayed** on the meter. If possible, the code should be associated with the type of material such as sand (in Polish - piasek) - PIA etc..
- ten characters of **material name** - enter the name of the material such as sand, etc.
- **number of active points** - enter how many points are active in the characteristics (2...15)
- **characteristic points** - enter calibration points, the maximum number of points pairs is 15, the first and last point mark the end of the measuring range - it will be indicated by flashing a result of the measurement, using the "*wykres*" (chart) button you can see how the characteristics looks visually and whether the points are entered correctly,
- **calibration certificate number** - does not apply, you can type any indication,
- **date of the sheet creation** - date when the characteristic has been created,
- **the date of characteristic entering** - the date when the characteristic was written to the device,
- **temperature compensation coefficients** - if temperature compensation is activated, you should enter the coefficients values: $d = 1, a = b = c = 0$,
- **description of the material** - 40 characters, you can briefly describe the material.

After entering the characteristics to the meter, you should record characteristics on the disk with the "*eksportuj*" (export) command, this way you can easily restore the recorded characteristic in case of system failure (using the "*importuj*" (import) command).

2.7.4.1 Authorization keys.

For each copy of LB -797 there is assigned authorization key provided by the manufacturer, together with the LB79x program (on request). The key is related to the type of device and its serial number. The keys are stored in the directory: KEYS of the LB79x program (for example C:\Program Files\LB79x\KEYS). If the user does not have an authorization key for your his/her of the LB79x meter, the program only will operate in a demo mode (you can not make setting characteristics, etc.).

with the appropriate key should be copied to the KEYS directory (to read the key you should turn off and turn on the LB79x program). When selecting in the window of LB79x program select "Ustawienia→Klucze Autoryzacyjne" (Settings → Key Certificate Authority), you can read the current key.

2.7.5 Checking the meter readings for the new material

After entering the characteristics to the memory of the meter it is recommended to perform test measurements. The measurements should be performed in the measurement mode, after you press "material+" or "material-" (material) to select an appropriate material code that has been assigned to the new material. The measurement conditions should be identical as in the calibration process, for example a similar manner of the probe electrodes location in the material. The effect of test display is the humidity table, which is calculated by reference or humidity method measured with the LB -797 meter.

Standard Humidity [%]	Humidity LB-797[%]
6,4	6,2
11,8	12,0
18,9	19,2
29,9	29,4
42,7	42,3

Table 2 Example table of the values obtained from the validation of the LB -797 meter indications after calibration

2.8 Measurement of the dielectric constant of the material


To measure the dielectric constant of the material you have to enter the calibration mode (Chapter *Calibration meter for new materials*) and perform measurement as if the moisture in the material is measured. In the calibration mode, the meter shows the square root of the dielectric constant of the material, to obtain the dielectric constant you square increase the measured parameter, or press and **hold** the "**Pomiar POJ.**" button - then the display shows the dielectric constant of the material. Another way to measure the dielectric constant of the material is to save to the device characteristics of the material type 1:1 (two pairs of points are sufficient humidity - parameter (0,0), (10,10), **do not activate the temperature compensation !**). After creating the characteristic parameter measurement sqrtsteps (square root of the dielectric constant of the material) we select the appropriate by pressing material+ or material- button for the assigned to sqrtsteps. This way you will not need to enter the calibration mode to measure the dielectric constant of the material.


2.9 Displaying an additional information

This section describes additional messages, which are displayed on the meter.

2.9.1 Battery low voltage indication

The indication of the battery low voltage is two threshold:

- flashing sign  – flashing sign - poor battery but it is possible to make the measurements, it is a signal to buy a new battery,

- continuous illumination of the sign  and the inscription shown on the display:



indicates that the battery should be replaced.

2.9.2 Signalling excess of the measuring range

Exceeding the measuring range (bottom and top), for both humidity and temperature, is indicated by the **flashing** of the measurement result. In special cases, the flashing of the measurement result may indicate damage to the meter. In the case of measuring conductivity there is not signaling the range - it is only a short signal electrodes short circuit- ErL.

2.9.3 Signaling an electrodes short circuit

If during the measurement of humidity or conductivity on the display alternately with the result of humidity shows the message:



this means that the probe electrodes short circuit (too high a conductivity of the material caused by salinity). Then the measurement of humidity is significantly erroneous and its interpretation should be performed with caution. **Note:** This message may mean an erroneous reset of the meter (especially when it is displayed and the electrodes are not located in the material), so you should try to reset to zero the meter as instructed.

2.9.4 Displaying the serial number

Entering displaying the serial number is done by selecting the appropriate menu option (see *Menu Mode*). The menu item is named "nr" (number) may be used to display the serial number. Please confirm the menu selection with the "TAK" (yes) button, then the serial number will be displayed. The menu is left by using the "NIE" (NO) button.

2.9.5 Signaling the automatic temperature compensation

Automatic temperature compensation is indicated by a flashing sign °C.

2.9.6 Signaling the operation mode of LB- 796 as a reading panel

When LB- 796 works as a reading panel there is flashing colon ":" on the display. Then all measurements, which are displayed are related to the probe, not to the LB- 796 panel, which also has its own measuring functions. Their starting is similar to the LB -797.

2.9.7 Other messages

- When you turn off the meter the following message displays briefly:

OFF

meaning that after a while the meter will switch off. If it does not switch off you have to turn the device off by pressing the "wyl" (off) button.

- After switching the capacitive method on, the message appears after several

CAL

seconds: which means the automatic zeroing of the probe (you should not touch the electrode probe at that moment).

- If after you turn on the meter or during its operation the meter displays the message:

Er_x

where $x = 0, 1, 2, 3$ or 7 , it means, that this is the time to deliver the meter for the service. When $x = 2$ - you can try to hold the "material+" button for about 10 seconds till the sign '---' shows up and wait a few seconds after that. If you still see the Er₂ message you should be deliver the meter to the service. When the message OFF shows up, you should turn off and turn on the meter.

- message:



Er₄

indicates that there is not stored in the meter any material characteristic.

- message:



Er₅

means that there is not stored in the meter any characteristics of the material in the resistive method - the message is related to the LB- 796 panel.

- message:

Er₆

indicates a communication error between the LB- 796 and LB -797 probe. Generally, this error occurs if you disconnect the probe and the panel LB- 796 during measurements.

- message:

Er₈

means that the reset has not been properly carried out. You should turn off the meter and try to reset again.

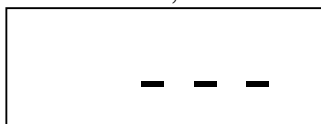
2.10 Validation hygrometer readings

- Validate meter readings to be made in calibration mode, so be sure to enter this mode (see the *Chapter Meter calibration for new materials*). The hygrometer, if the electrodes are dry and clean, should indicate the parameter value 1.00 ± 0.2 , otherwise you should reset the probe. After immersion in water the hygrometer should indicate the *sqtrsteps* parameter value equal to 9.0 ± 0.3 for water at 20 °C.

2.10.1 Resetting the probe to zero

To reset the probe to zero:

- Clean and dry the probe electrodes, **the electrodes can not be placed in the material**,
- activate the temperature measurement mode with the T/TH button (above the button there is the inscription **ZERO (2sek.)**). Then hold the button for about two seconds, and after a few seconds a sign will show up on the display:



and the meter returns to the temperature measurement, this means the end of reset to zero. During the zeroing you may not touch the probe electrodes. Resetting to zero should be carried out every few weeks after validation of the readings.

2.11 Notes on use

1. In the case of longer periods of the device inactivity, it is recommended to remove the battery from the LB- 796 panel in order to avoid pouring out of the electrolyte.
2. It is recommended to use good quality batteries (alkaline, lithium).
3. You should not unplug the LB- 796 panel during device operation. Before the battery removal the keyboard should be switched off.
4. Do not allow water to splash on the LB- 796 panel or dew to condensate on it.
5. Protect your hygrometer against exposure to strong sunlight, which can lead to overheating of the device.
6. The hygrometer does not require maintenance.

3. Output voltage 0...10V

The LB -797 probe is equipped with a voltage output of 0..10V. **Before permanent placing the probe on the solid material such as soil, the probe should be properly configured (save the appropriate characteristics of the material).** In the output mode the voltage corresponds to the humidity calculated on the basis of the characteristics of position 1. 0.1V voltage corresponds to 1% relative humidity.

To start voltage output mode, connect the gray wire (RxD) to the white wire (GND). Wiring diagram is shown in the figure below.

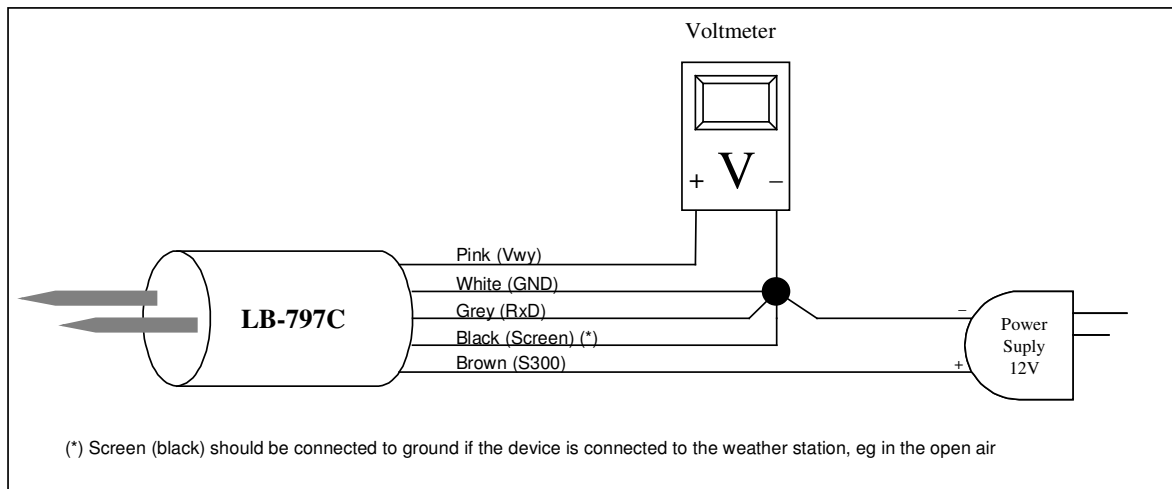


Figure 4 Connection of the LB - 797C probe in voltage output mode

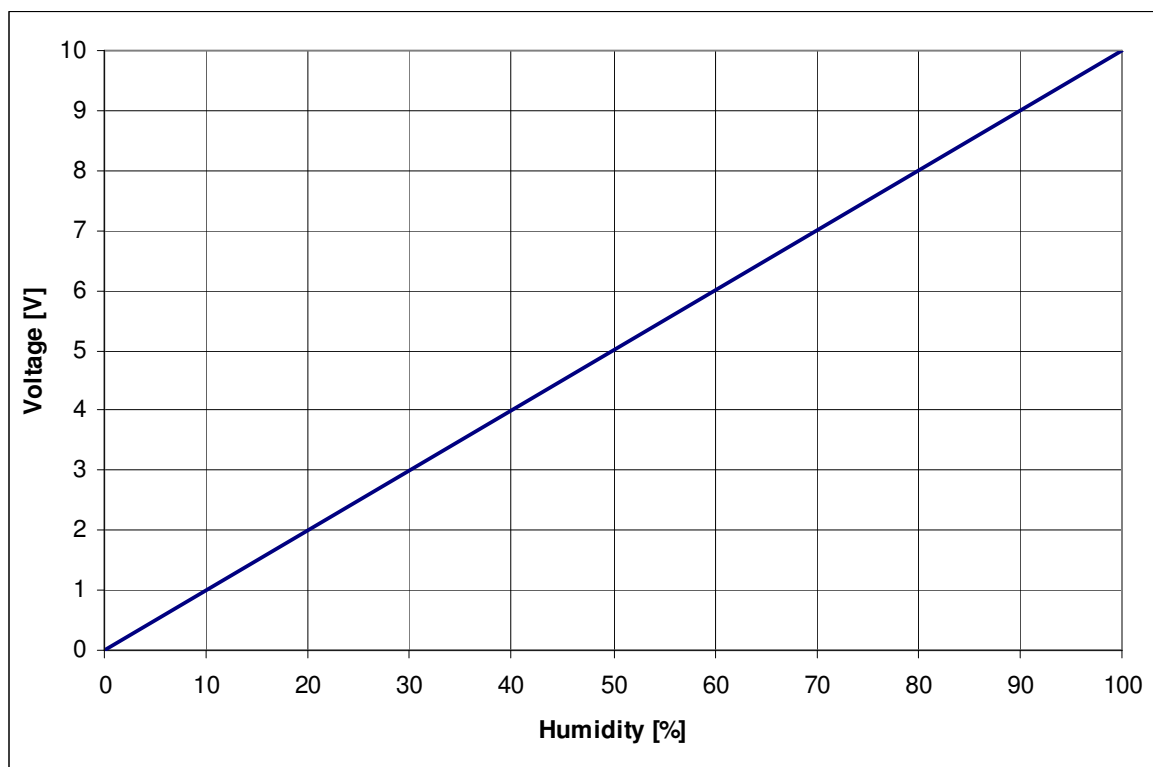


Figure 5 Output characteristics of the LB - 797C probe in voltage output mode

4. Connect the LB - 797C probe to PC via S300 interface - description of the LBX program

The LB-797C probe is equipped with an interface of S300 digital current loop, which allows measurements transmission over long distances. This interface, except the data transmission, is also used for power supply to the probe. It uses for that the two-wire line, the polarity of attaching the interface cable is arbitrary (the maximum length of the interface wire is 2 km). It is a one-way interface - for data read-only. **There are no options for device configuring by this interface. Before placing the probe in the material such as soil, it should be configured (save the appropriate characteristics of the material). Humidity read via S300 is calculated on the base of the characteristics with the number 1.**

Via the S300 probe can be connected to a superior system of data collection such as:

- LB- 473 – 8-channel hub with Modbus -RTU interface (EIA -232 or EIA- 485)
- LB -489 – 4-channel data acquisition with the Ethertnet interface,
- LB -489 – 8-channel data acquisition with the Ethertnet interface,
- LB-741 – meteorological station.

The S300/USB LB -375 converter is applied for the direct connection of the sensor to the computer. The computer program can read measurements with LBX program. Install this program from the supplied media (updates are available on the http://www.label.pl/po/lbx_program.html) – run the program setup and follow the instructions of the installer.

The LBX program has many additional features, about which learn after the assistance starting. The LBX program displays four parameters read from the LB -797:

- moisture content in the material (**calculated on the basis of characteristics number 1**),
- temperature of the material,
- the dielectric constant of the material,
- conductivity of the material.

When the measurement of any parameter is incorrect, its field will be highlighted in red.

No.	Function	Color	Description
1	S300	Green	S300
2	RxD	Grey	RxD
3	TxD	Yellow	TxD
5	GND	White	Common
6	S300	Brown	S300
8	Vwy	Pink	Voltage output
9	Screen	Black	screen

Table 3 Table Numbering and function of the wires in the DB9M plug of LB-797C probe

If you use only the S300 cables or voltage output without DB9M plug, the cables must be **insulated**.

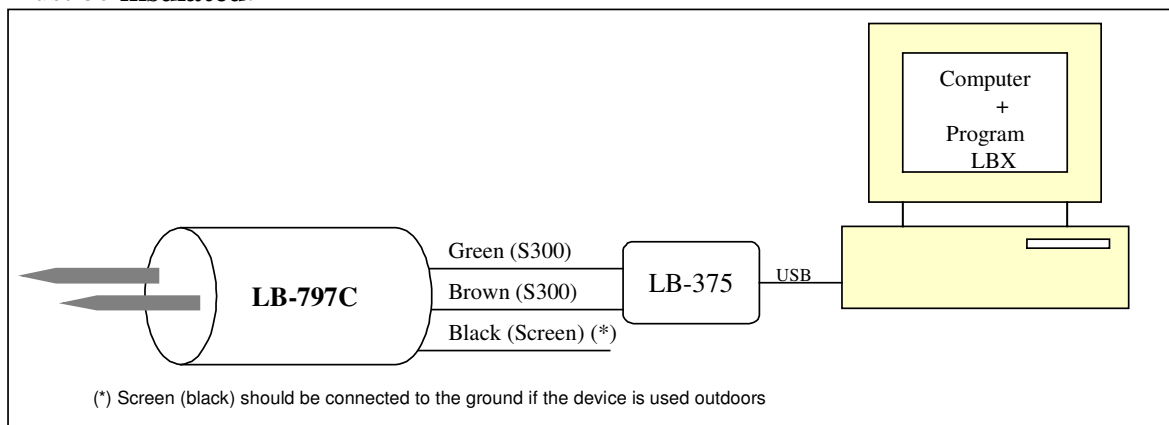


Figure 6 Connection of the LB - 797C probe to PC via LB -375

4.1 Description of the LB -375 converter

The following figure shows the LB -375 converter.



Figure 7 LB-375 converter

NOTE: It is recommended that you install LBX before the first connection of the LB -375 converter to your computer.

The LB -375 converter provides galvanic isolation between the probe LB-797C and USB computer interface circuits. The converter LB-375 is equipped with two LED indicators:

- **PWR red LED** - when this LED lights up it indicates a proper converter connection to PC (proper installation of drivers),
- **TX/RX green LED** - blinking LED indicates the correct sensor communication with the computer.

Using the USB cable included in the converter set, connect the LB -375 converter to your computer (marks on the converter housing). Windows system should report and recognize the new USB LB-375 device (only at the first time after you connect).

The red PWR LED should light up on the converter LB-375. The S300 LB-797C sensor should be connected to the converter on the side of inscription.

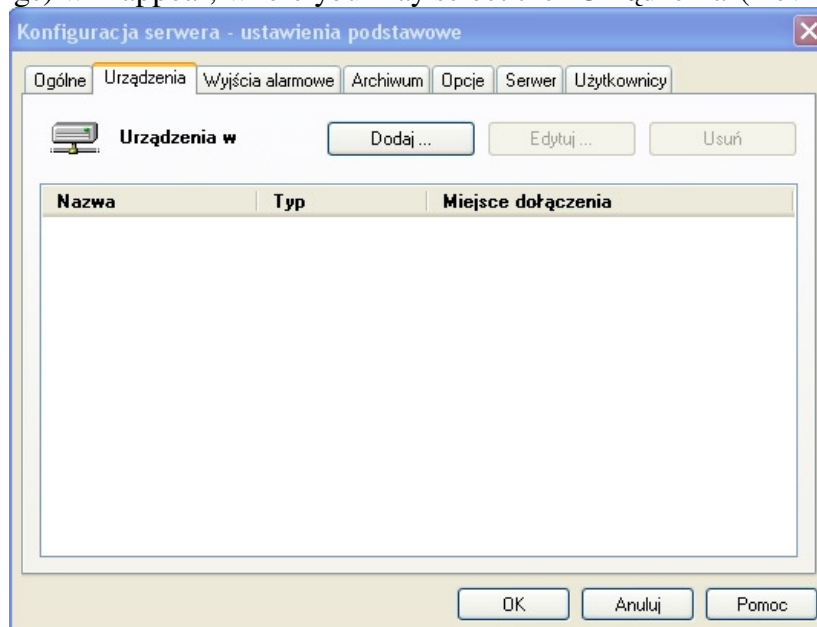
If for some reason the system does not recognize correctly the LB-375 converter (dimmed red light after connection to a computer), you have to manually install the driver (before that you may try to restart your computer). The driver is located in the LBX (for example C:\Program Files\LAB EL\LBX\drivers\usb_lb375_lb487). To do this, use the Windows Device Manager to find improperly installed the USB device and update the driver by indicating the previously described directory, as the location from which you wish to download a new driver.

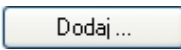
Note: Regardless of the number of owned converters, the driver installation is performed only once and it should not be repeated for each of your converter.

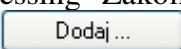
4.2 Configuring the LBX program

After you install the LBX program on your computer, you need to properly set it up (this is also possible at the stage of the installation). All the features of LBX program are described in the "Pomoc" (Help) menu.

The configuration consists of adding two device to the LBX program server: the LB-375 converter (as an intermediary device) and LB-797C probe. Run the menu "Serwer → Konfiguracja Podstawowa" (Server → Basic Setup). The window "Konfiguracja serwera – ustawienia podstawowe" (Server Configuration - Basic Settings) will appear, where you may select the "Urządzenia"(Devices) tab.

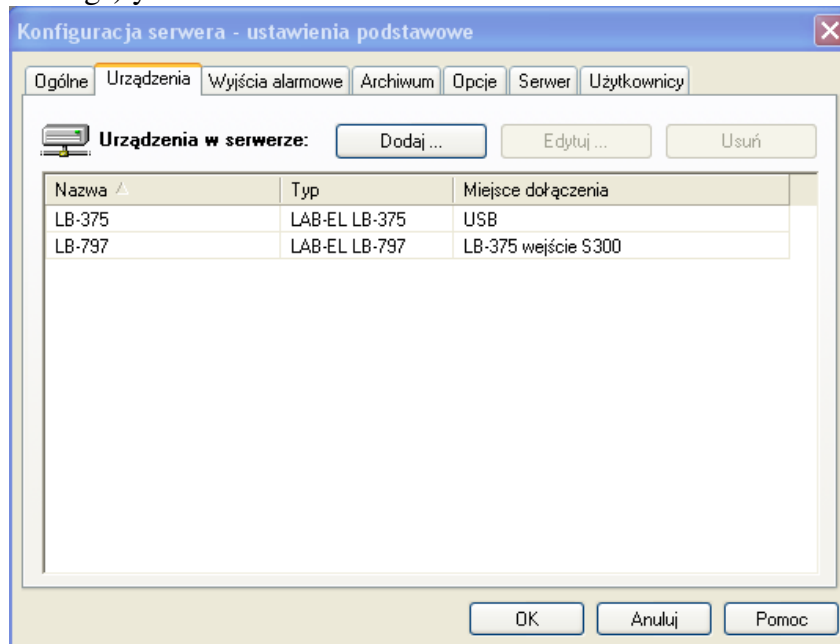


Press the button  - another window will appear where you may select the device from the drop-down type list: LB -375 (enter a descriptive name, for example the same as the name of the instrument). As a point of attachment please select *USB*. Accept the changes by pressing "Zakończ" (Finish).

Once again, press the button  to add the LB-797 device (for example, enter a descriptive name, which may be the same, as the name of the

instrument). This time select, as a point of attachment, "*Urządzenie z serwera*" (device from the server) (from the drop-down list select the LB -375, as an input - S300). Accept the changes by pressing "*Zakończ*" (Finish).

In the "*Konfiguracja serwera – ustawienia podstawowe*" (Server Configuration - basic settings) you should see two devices: the LB -375 and LB -797.



Press the OK button to confirm the addition of these devices. The LBX program should establish communication with the devices in seconds - they are shown in the left LBX window or in the "*Urządzenia*" (Devices) menu. To view the current measurements, run the menu "*Urządzenia → LB-797 → Dane*" (Devices → LB-797 → Data). The window displays as on the figure below. For more information about LBX and its capabilities view the help for LBX ("*Pomoc*" (Help) menu).

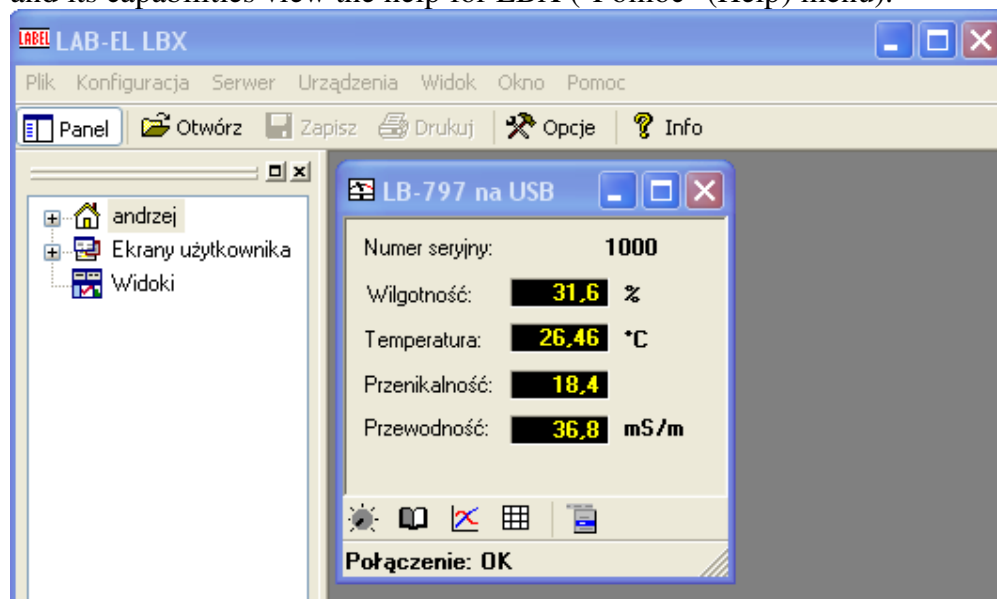


Figure 8 Sample LBX program window after connecting the LB -797 sensor

5. Measurement Specifications

This chapter presents the metrological parameters of the instrument for measuring temperature, humidity and conductivity. Measuring range of materials available in the meter is shown on the additional annex to this manual.

The hygrometer tends to show a mass humidity, which is defined as follows:

$$w[\%] = \frac{\text{water mass contained in the material}}{\text{mass of the absolutely dry material}} \cdot 100$$

If humidity is defined otherwise, it is indicated in the additional annex to the manual (kg / kg - mass moisture, m³/m³ - volume moisture). It is possible to scale the meter to indicate the humidity defined in other method.

PERFORMANCE DATA FOR MATERIAL MOISTURE	
Measuring range	depending on the type of material (shown in the table with a list of materials)
Resolution of measurement	0.1%
uncertainty of measurement	1% for moisture density in a dedicated calibration, 3% without calibration
	3 % of the value measured for mass moisture
PERFORMANCE DATA FOR MATERIAL CONDUCTIVITY	
Measuring range	0... 200mS / m
Resolution of measurement	0.1 mS / m
Uncertainty of measurement	10 % of measured value
PERFORMANCE DATA FOR TEMPERATURE	
Measuring range	-20..70 °C
Resolution of measurement	0.1 °C
Uncertainty of measurement	± 0.2 °C

6. Technical specifications

OUTPUT VOLTAGE	
Range	0...10V
Maximum load of the output voltage	20 kohm
POWER	
Battery	6F22 9V battery - for the panel LB-796P
Other	When communicating with a computer, the meter is powered by the computer
Power consumption	8 mA - temperature measurement
	17... 22 mA - measurement of humidity and conductivity
OPERATING TEMPERATURE RANGE	
device	range
LB -797	0...+60°C
LB- 376c	-20...50°C
DIMENSIONS	
LB- 797A without electrodes	diameter 40mm, length 240mm
LB- 797C without electrodes	diameter 40mm, length 160mm
LB- 376C	56x31x24mm
electrodes	diameter of 3 mm and a length of 60mm, 25mm distance
drill	diameter of 65mm and a length of 1 meter
pipe for the probe inserting	40mm diameter, 1 meter
density of LB -797 housing	IP68 – not applicable for probe plug
density of housing LB- 376c	IP30
OTHER PARAMETERS	
Electrode material	stainless steel 1H18N9
Standard cable length	1 meter LB-797A, 3.5 meters LB-797C
Maximum cable length	10 meters to communicate with LB-796, 2km for the S300 interface, 50 meters for a voltage output
Life in the soil	about 10 years