Operation manual

nano-H

AL-250 Precision resonant inductance meter

1v01

⚠ SAFETY PRECAUTIONS

The appliance is intended for indoor use only.

Place the appliance on a secure and level area.

Check if the voltage indicated on the appliance corresponds to the local mains voltage before you connect the appliance.

Plug the appliance into a 230V alternating current socket equipped with an earth pin only.

Do not use the device with a defect, especially with a damaged power cord. The device should only be used with the fuse indicated on the nameplate.

Never attempt to plug in or unplug the device from the power supply when your hands are wet.

Always push the plug all the way into the power outlet.

Never damage, modify, stretch or excessively bend or twist the power cord. Do not place heavy objects on the power cord.

When the device is not in use, unplug the device from the outlet.

Before you start cleaning the measuring socket, remove the plug of the connecting cord from the socket.

If you detect smoke, unusual smells or strange noises around the device, immediately unplug the machine at the power supply and call for producer.

The device emits low level electromagnetic field. If you use a cardiac pacemaker and feel abnormalities, please move away from from this appliance and consult your doctor.

Be careful to prevent foreign objects from entering the inside of the device. If any foreign objects (metal or liquid)fall into the appliance, unplug the power cord, and call for producer.

To protect against electrical hazard, do not immerse in water or other liquids. Do not use near water.

Do not attempt to disassemble or modify the device. There are no user serviceable parts inside the appliance.

Dear Customers,

we provide you with a resonance meter of small inductances with unique parameters. This device is a result of many years of research and design work.

We emphasize that it is completely our project: starting from the design of the structure of the systems, through mechanical work on the unique socket, to designing graphics and assembly.

The device is specially dedicated to measuring very small inductances, even ***a few nanohenries.***

A special measuring socket *with a unique design allows the user to very conveniently measure coils with different housings.*

We are proud of our device and it will be a great satisfaction for us if you take advantage of the meter measuring capabilities.

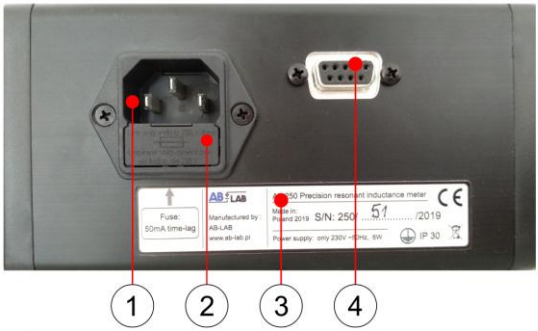
We wish you satisfaction with our product.

A.B.-Lab Engineers

TOP PANEL

1. Power button
2. Display
3. Range button - change of range
4. Case button - housing selection
5. Calibrate button - zero calibration
6. Measuring socket
7. Power supply indicator
8. Warmed-up indicator
9. Warning indicator - uncertain result

REAR PANEL

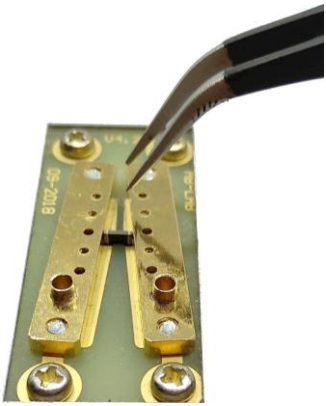


1. Power connector with fuse
2. Fuse
3. Nameplate
4. Multi-pin service connector

Important: Do not use multi-pin service connector secured with warranty sticker.

MEASURING SOCKET - INTRODUCTION

The measuring socket has been **specially designed for the nano-H meter.** It allows you to quickly and conveniently measure coils in SMD housings and typical air coils.
Socket contact elements are gold plated. This ensures long-term use without worrying about poor contact.



Measurement of SMD coil

The SMD element is inserted with tweezers into the gap between the contact bars - the element should be wedged up between the bars.

Measurement of THT coil

The coil pins should be inserted into a pair of holes of both contact bars.
The special design of the holes ensures the coil pins slightly wedge in the holes. This gives good electrical contact. The pins also wedge when the wire diameter is smaller than the hole diameter. For example, if the coil pins are 0.5mm wire and they are inserted into 0.8mm holes, the contact will be correct.

WARNING. If the measured values are small **(below 10 nH)**, zero calibration should **be performed first - see chapter IV**.

I. DEVICE CHARACTERISTICS

The nano-H resonance meter is specially designed to measure very small inductances.

The general idea of measurement is based on **changing of resonance frequency** by the measured coil.

Resonant measurement

Compared to classic impedance meters, nano-H uses a different method - *measuring the resonance frequency* of the LC circuit. The specially designed resonance measuring circuit practically eliminates both the influence of the parasitic capacitance of the measured coil and the series resistance r_S of the measured element. The resistance r_S does not affect the value of the measured inductance (however, if the r_S is too high and the Q-factor of the coil is very low, the measurement will not be possible at all).

Advantages of resonance measurement:

1) At small inductance values, the measurement is technically easier.
2) The device may have a simpler, more compact design and be more convenient to use.
3) The same quality of measurement (for small inductances) can be obtained at a lower cost, which affects the price of the instrument.
4) The measurement takes place at relatively low frequencies. At such frequencies, the influence of the parasitic parameters of the coil **is practically negligible**, and the measurement accuracy is maintained.

Limitations of resonance measurement:

1) Limited measuring range - it is difficult to measure large inductances using resonance technique
2) As a result of measurement only inductance is obtained. This technique cannot directly determine the Q-factor of a coil (or series resistance).

The instrument can measure inductances **with an absolute error of 0.**2nH if the instrument has been calibrated based on a reliable standard with low inductance. This is the main limitation of measurement accuracy - there are no calibration standards for very small inductances.

Important: The measurement of coils, due to their complex structure (parasitic parameters), depends on the measurement technique. Therefore, the measurement of the coil made with a classic bridge meter can differ by up to several percent from the result obtained using the resonance technique.

II. TECHNICAL SPECIFICATIONS

Range: 1 - 0 .. 20µH

Absolute error[1]: does not exceed 0.2nH (after warmed-up and user calibration)
Absolute error without user calibration: does not exceed 3nH
Measurement relative error for calibration standard 200nH: does not exceed 2%
Relative error for whole range 4% tipical, does not exceed 6.5%
Maximum resolution: approx. 20 pH
Measurement frequency in range (depending on measured coil): 1 .. 6MHz.

Important: Yellow indicator ***WARNING*** means that the results can be unreliable!
The indicator turns on in rare cases: at coils with poor parameters (for ex. low Q factor), with large parasitic capacitance of the coil or at near end of the range.

WARNING. Range 1 is desined to measure high frequency coils. This criterium is met by coils without a core (air coils). They can also be coils with a core made of high frequency ferrite (over 6MHz). **Measuring a coil with a wrong, "slow" ferrite core** can result in a significant **measurement error.**

Range: 2 - 15µH .. 500µH

Absolute error: does not exceed 50nH
Measurement relative error for calibration standard 10µH: does not exceed 2%
Measurement relative error for calibration standard: does not exceed 2%
Relative error for whole range 1µH .. 200µH: does not exceed 6,5%
Measurement frequency in range (depending on measured coil): 60kHz .. 300kHz

WARNING. Errors given above refer to resonant measurement. Using other methods of measurement can give slightly different results.

Important: Results that are **smaller than 15µH and greater than 500 µH** in Range 2 can be unreliable!

[1] In relation to calibration standard

Important: Yellow indicator ***WARNING*** means that the result can be **unreliable!**
The indicator turns on in rare cases: at coils with poor parameters for ex. low Q factor, with large parasitic capacitance of the coil or at near end of the range.

Range selection
Switch Range selects Range 1, Range 2 or Auto (A1, A2).

WARNING. When measuring very small values, it is recommended to turn on Range 1. Do not use Auto mode, because the accuracy of the measurement decreases in this mode.

III. ADDITIONAL PARAMETERS

Minimum Q factor of measured coils: 4

Display: LCD 20x2 (20 characters, 2 lines)

Buttons:
RANGE – range of measurement (Range 1, Range 2, auto)
CASE [2] – selection of the housing of the measured element (603, 805, 1206, USR1, USR2)
CALIBRATE – zero calibration

Indicators:
POWER – power supply is on
WARMED-UP - the meter is warmed-up full accuracy is achieved
WARNING - the measurement may be incorrect
Under typical conditions the meter achieves full warmed-up after 6-15 minutes (20..25°C, humidity 20 ..80%).
Level of electromagnetic radiation: less than 1mW.

[2] For elements of unusual sizes, the CASE button should be used to select the closest housing type, e.g. for item 1210, select housing 1206

Power supply:
Supply standard: 230V/50Hz

Power consumed: does not exceed 6W

Fuse: 50mA, time-lag.

DANGER. Do not use other type of fuses - a fire hazard!

DANGER. Do not use other supply standard!

DANGER. Power connector should be grounded: danger of electric shock and improper measurements!

Dimensions: 230 x 150 x 80mm
Weight: 1050g

Protection class: IP 30

Recommended working conditions:

The device is designed to work in laboratory conditions. Working in dusty conditions is not recommended.

Ambient temperature: 15-25°C

Humidity: 20-80%

WARNING. The device cannot work in the presence of strong electromagnetic fields.

IV. MEASUREMENT

The meter makes 2 measurements per second – they are updated on the display.

The whole measurement consists of the following stages described in the following sections:

- Instrument warming (until the WARMED-UP indicator lights up). If the measurement will not concern very small values the measurement can be started immediately after turning the meter on.
- Zero calibration - necessary for very small measured values (chapter V of the manual).
- Selection of the measuring range (chapter VI).
- Placing the element in the measuring socket (chapter VII).

V. ZERO CALIBRATION

The calibration of the device is of great importance because the measurement sensitivity is very high. The first, main calibration (calibration of characteristics) is performed by the manufacturer. However, it is up **to the user to perform a zero calibration** - necessary for the most sensitive measurements.

It is worth noting that with values of a few nanohenries you can see the differences between the inductances of the housing. For example, the difference in the inductance of a 0603 enclosure, and a 1206 enclosure can be almost double (depending on the manufacturer of the item). Therefore the meter distinguishes between different housing sizes of SMD components (603, 0805, 1206).

Calibration is performed separately for the First Range (1) and Second Range (2). The calibration is particularly important for the First Range (1).

The correct measurement of very low inductance consists of the selection of the housing size and calibration of this element size.

Important: The calibration procedure does not start if:

- the parameters of the element used for calibration are not correct (i.e. the resistance and inductance of the element are too high),
- no calibration element placed in the connector.

In this case, "Calibration failed" appears on the display.

Important:

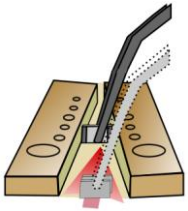
1) At very low inductances, the measurement result depends on the positioning of the element in the socket. Therefore, this operation should be performed with great care!
2) For calibration, use the special elements (jumpers 0603, 0805, 1206) supplied with the instrument. The manufacturer is not responsible for the use of untested elements.

Calibration of case 0603

1. Warm the instrument - wait until the WARMED-UP indicator lights up (necessary for the most accurate measurements).
2. Set on the measuring range: first or second (not AUTO). Calibration

should be performed on the selected range. Use the CASE button to select the case size - the display will show the case 0603.

3. Insert the calibration element of the above size (0603). This element (jumper type) is provided with the equipment.



The calibration jumper should be placed in the measuring socket by the tweezers as shown in the picture. The element's contacts should adhere to the connector's contact bars (wedging between the bars), and the element itself should **be placed vertically**. Move the tweezers away from the connector before performing the calibration.

4. Press CALIBRATE button

Important: Each **calibration element has its own inductance** (approx. 800pH .. 1.8nH), and such the value will appear on the display.

Important: If the measurements are for very small values only, set range 1 and wait until to WARMED-UP indicator lights up. Turning on AUTO mode (on the display Range: A1 or Range: A2) will reduce accuracy!

If one measures relatively large inductances (about 20nH and more), you can opt out of heating the instrument and calibrating.

Calibration of case 0805 and 1206

Calibrations for 0805 and 1206 cases are performed in the same way as for 0603 case by selecting the appropriate enclosure type using the CASE button.

Calibration of case USR1 and USR2 - relative to the reference element

In some situations, you may need to measure coil in refer to a specific reference element. Such a reference element may be a user-owned jumper with known properties or a coil with known inductance. In this situation, USR1 or USR2 calibration can be used. Such calibration is done in the same way as above, but instead of the calibration jumper the user introduces his own jumper or coil. The only difference is that the calibration algorithm cannot take into account the inductance of this element in this matter - therefore, the measurement error (mainly absolute error) increases.

The value of the reference element is saved in the non-volatile memory of the device (EEPROM), so you can use this value the next time you use the meter.

VI. RANGE SELECTION

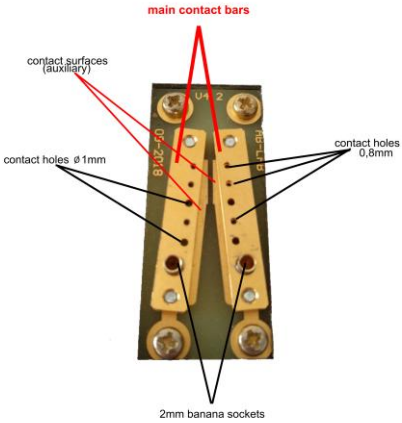
The instrument has two ranges of measurement. The first range is for measuring coils with the lowest values, while the second range is for measuring larger ones. The selection is made by the RANGE button.

Subsequent clicks turn on to the first range, second range and Auto mode. The display shows respectively:
Range:1
Range:2
Range:A1 (measurement of small values in Auto mode)
Range: A2 (measurement of large values in Auto mode)

When the measured coil is too high, or if there is no element in the socket, the display signals “out of range”.

VII. MEASURING SOCKET

The nano-H meter has a built-in measuring socket, in contrast to typical RLC bridges, in which the sockets are separate modules. This solution allows you to make a measurement much faster and more conveniently.



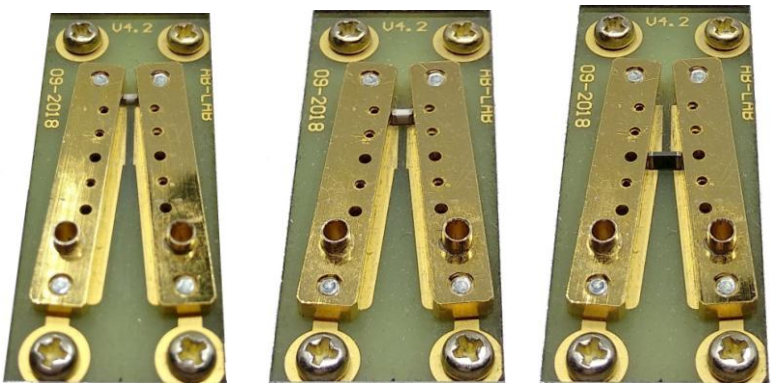
Socket components:

- **main contact bars** - for measuring SMD coils
- **auxiliary strips** - for measuring coils with the skids type contacts (the element has the contacts only below it)
- **holes of different diameter** - for measuring THT coils
- **banana sockets (2mm) for connecting measuring cables** - for measuring of wire inductors with diameter of wire greater than 1mm and those with soft leads.

Using the socket for measurement SMD coils

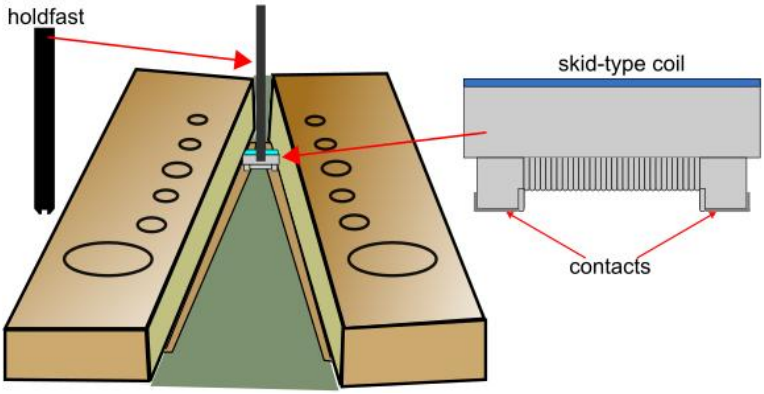
There is no need for any additional connectors when measuring typical SMD components. The measurement is convenient and fast. The connector has no movable parts, which facilitates calibration and ensures good repeatability of results.
In the connector you can measure SMD elements in the following cases: **0603, 0805, 1206, 1210.** It is worth to note that measurement of components in 0603 housings is the most accurate. For measuring elements in 1210 housings, use the "CASE" button to select "1206".

0603 0805 1206



Important: some SMD coils have "skid" type contacts, i.e. their electrical contacts are only accessible from the bottom of the element.

Such coils cannot be measured by typical wedging in the socket.
Measuring of such elements involves placing them tightly between the contact bars, but without wedging. To ensure contact between the element and the bottom contact surfaces, press the measured coil from above using the supplied holdfast (it is suitable for most 0603 skid-type coils). Elements of this type in size 0603 should be placed as close as possible to the upper edge of the contact fields - see the picture below.



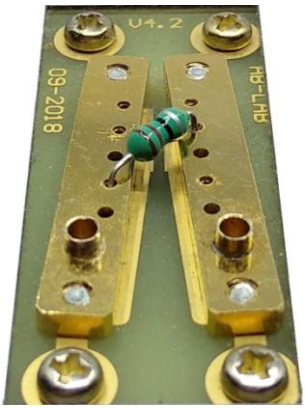
Using the socket for measuring THT coils

Measurement of the THT coils is also easy due to the design of the holes: their special design ensures contact with the leads after inserting the element into the holes. The exception are components with soft leads - such components must be measured using auxiliary cables. Leaded and wire inductors have a very different structure, so they do not have their representation in the set of housings included in the menu. **When measuring such coils, select the 0603 case - this gives the slightest measurement error.**

IMPORTANT. For THT elements: push until slight resistance. **For a typical through-hole element, the appearance of mechanical resistance during insertion means contact.**

The maximum length of inserted leads is 10mm! Longer pins inserted into the socket can damage the meter!

In the photo:
measurement of a typical silver plated wire coil



In the photo:
measurement of a typical axial inductor

In the photo:
measurement using measuring cables

Of course, the measurement of THT components is less accurate than SMD components.
It results from the influence of leads on the result: the meter is able to measure the inductance of approx. 1nH - it could be inductance of 1 mm wire (approximately).
So if the element was inserted once to a depth of 5mm and the second time of 6mm, one should expect a difference in results of 1 .. 2nH (depending on the thickness of the wire).

To make the measurement more convenient of THT elements with different pin raster several holes are provided in each of the contact bars.
Two holes (first and third from the bottom) on each contact bar have a diameter of 1mm, the others - 0.8mm. This allows you to choose the holes that match the item.

Important: Most components (e.g. typical axial chokes) with thinner leads (e.g. 0.5mm) can also be measured, the design of the holes also provides contact for such leads.

It is not necessary for the measured element to be positioned perpendicular to the joint axis - it can be in a slanted position.

Important: When measuring THT coils, select case 0603.

Cleaning the socket

Keeping the measuring socket clean is necessary to obtain correct measurement results.

To ensure long-term operation, the socket elements are gold-plated. However, after some time the holes and contact bars may get dirty. If possible, avoid contaminating contact holes - the leads of the measured elements should be free of rosin, deposits and excess tin. Therefore, after

some time, the quality of contacts may deteriorate. Therefore, the connectors should be cleaned from time to time - e.g. using the included brush and available preparations for maintaining electrical contacts (not included). It is recommended to clean the socket every two months on average, with frequent use more often.

WARNING. Do not use **ordinary solvents** - use only agents used for electronic contacts in small quantities (do not flood the inside of the meter!).
Insert the brush to a depth of not more than 10mm.

Incorrect cleaning may damage the meter and will void the warranty!

If the meter is not used, the socket should be covered with the enclosed lid - as in the photo beside.

VIII. ACCESSORIES

The device comes with the following accessories:

- power cable
- spare 50mA time-lag fuse
- tweezers
- jumpers for calibration 603, 805, 1206
- holdfast for skid-type coils (with leads from below)
- measuring cables
- measuring socket lid
- socket cleaning brush
- manual
- warranty

IX. ADDITIONAL REMARKS

In very rare cases, the instrument may indicate the inability to perform the measurement. The reason may be very poor coil quality (very low Q-factor, very high parasitic capacity) or "slow" core of the coil. In this situation, the following messages may appear on the display:

Error: Rel
Error: Fr
Error: Fsum

In other rare situations the device may enter the service mode. In this case, an appropriate message may appear, e.g.:

Cr Lrow calibration

You should stop using the instrument and contact the manufacturer if one of the above messages persists after the meter has been reset (off and on again) and there is no coil in the connector, or the message persists for any measured coil.

The design of the device may change regardless of these instructions.

The latest version of the Manual is available for download at **www.ab-lab.pl.**

Disposal of Waste Electrical & Electronic Equipment

The symbol (crossed out wheeled-bin) on your product indicates that the product shall not be mixed or disposed with your waste, at their end of use.

This product shall be handed over to your local community waste collection point for the recycling of the product.

For more information, please contact your Government Waste-Disposal department in your country.

Inappropriate waste handling could possibly have a negative effect on the environment and human health due to potential hazardous substances. With your cooperation in the correct disposal of this product, you contribute to reuse, recycle and recover the product and our environment will be protected.