

Instruction Manual for the Coating Thickness Gauge **LEPTOSKOP 2042**

Rev. 1.4

This manual is part of the delivery of the
LEPTOSKOP 2042 with serial number:

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1 Scope of delivery



Fig. 1: The LEPTOSKOP 2042 in the carrying case (equipment example)

- LEPTOSKOP 2042 in protective holster
- 2 batteries, size AA
- instruction manual
- quality test certificate
- carrying case

in addition, optionally*:

- sets of calibration foils
- test block Fe
- test block NFe
- probes
- PC software "EasyExport"
- PC software "EchoStat 2002"
-
- * depending on scope of order

2 About this manual


The LEPTOSKOP 2042 is available in several upgrade levels and can be enhanced via an unlock code whenever you want. This manual deals with all upgrade levels. Descriptions which possibly are true only for individual upgrade levels are designated as follows:

Symbol	Upgrade Level
B	Basic unit
S	Module "Statistics"
D	Module "Statistics & Data Memory"

3 Application range

- With NFe probes the gauge is used to measure the thickness of electrically non-conductive coatings on non-magnetic electrically conductive substrates (e.g. aluminium, brass, copper) by means of the eddy current method (DIN EN ISO 2360).
- With Fe probes the gauge is used to measure the thickness of non-magnetic coatings on magnetic substrate (e.g. iron, steel) according to the magnetic-inductive principle (DIN EN ISO 2178).

4 Important notes (read prior to first start-up!)

- The gauge must not be used in explosive environment. Follow your respective safety rules.
- Don't switch the instrument on or execute measurement while it is exposed to electromagnetic **interference fields!**
Keep the measurement set-up (instrument, cable, test block etc.) away from sources of magnetic fields (neon light, transformers, mains units, electric motors etc.)!
This will avoid influences on the measurement result by external magnetic fields and magnetization of parts under test.
- If interference fields have been detected...
 - ... the display will show the symbol 
 - ... measurement is not possible (the last measured value will remain on the display)
 - ... an acoustic error signal is generated.
- Ensure that the substrate is free of magnetic remanence to a large extent.
- Use test blocks only to check the proper function of the instrument. If a special measurement calibration is required (see section 12) you need to use the actual substrate for calibration.
- With soft layers even a slight contact pressure may deform the surface and falsify the measuring result. In this case try to place the probe without spring force. Or select a compensating offset value (see section 10.2.3) if either the upgrade level "Statistics" **S** or "Statistics & Data Memory" **D** is installed.
- The LEPTOSKOP 2042 is equipped with a monitoring unit for the battery capacity which will switch the gauge off if a non-sufficient voltage supply is detected. Prior to final switch-off caused by an empty battery an alarm sound is generated. Set-up and calibration is memorized.

5 Contacting KARL DEUTSCH

We work flexitime. During the core hours you surely can contact us:

Monday through Thursday	9.00 am to 12.15 pm / 12.45 pm to 15.30 pm
Friday	9.00 am to 12.15 pm
Phone	(+49 -202) 7192-0
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Office address	KARL DEUTSCH Prüf- und Messgerätebau GmbH + Co KG Otto-Hausmann-Ring 101 D-42115 Wuppertal

6 Controls, interface and cable



- 1 Display
- 2 Keyboard



- 3 Data interface for
 - a) Cable 1657.311 to connect to the 9-pin RS232 interface of a PC.
 - b) Cable 1657.312 to connect to the USB interface of a PC.
 - c) If the cable 1657.311 is completed with the adapter 1657.310 you can connect the printer 6010.001.

- 4 Probe connector
(marked with a red dot)

☞ *Position the probe plug so both red dots, each on the plug and on the socket, point to the same direction.*





- 5 Type label
- 6 Pop-up stand
- 7 Battery compartment



7 Keys and menu operation

7.1 Key reference



- ON / OFF key
 - Confirmation of input or of the indicated value
 - Menu call
 - Activation of the marked menu item (selected menu topics are shown in inverted characters)
 - With input: Moves the cursor to the right.
- ☞ *In the further course of the text this key is represented by .*
- ☞ *The tactile feedback of the key is under the symbol .*



- Quitting the current menu item -> move one menu level upward
 - With input: Moves the cursor to the left
 - In measurement mode: Illumination ON
- ☞ *In the further course of the text this key is represented by .*
- ☞ *The tactile feedback of the key is under the characters .*





- Move selection bar of the menu upward. Selected menu topics are shown in inverted characters.
- Increment (i.e. increasing the indicated value)



- Move selection bar of the menu downward. Selected menu topics are shown in inverted characters.
- Decrement (i.e. decreasing the indicated value)

7.2 Operating

- **MENU OK** calls the operating menu.
- Use the arrow keys   to move to the desired menu item and activate it by pressing the key **MENU OK**. If required the same method is used to branch into additional sub-menus.
- Selections are confirmed by pressing **MENU OK**. Use **ESC** to quit the menu topic without activation and to return to the next higher menu level (see menu structure in section 9).

7.2.1 Input of alpha-numeric values

Some selections (e.g. offset, limit, password, time, file name etc.) use alpha-numeric inputs.

- **Display:** **ESC** _XXXXX_ **OK**, where XXXXX is the current parameter value.

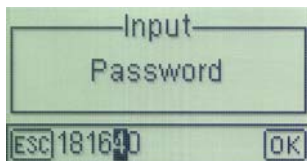




Fig. 2: Input of password (example)

- **Operating:** Key **MENU OK**: Used to shift the input cursor to the right
Key **ESC**: Used to shift the input cursor to the left
Keys  : Select content of the current input position

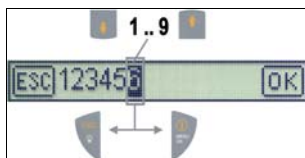


Fig. 3: Key assignment with numeric input (example value)

- **Confirm:** Shift cursor over **OK** and strike the key **MENU OK**.
- **Quit:** Shift cursor over **ESC** and strike the key **ESC**.

8 Putting into operation

8.1 Insertion of battery, change of battery

open:



(a)

(b)



(c)

close:



(d)

(e)

Fig. 4: Battery compartment on the rear of the instrument

- Prior to first putting into operation you need to insert batteries. For this purpose two 1.5 V alkali-manganese cells of size AA (Mignon) are part of the delivery.

☞ *Only change batteries if the gauge is switched off.*

☞ *You need not to remove the protective holster when changing the batteries.*

- Use the knurled screw to open the battery compartment on the rear of the instrument (a).
- Remove the cover of the battery compartment (b+c). Now the batteries are freely accessible.
- The graphical symbol in the battery compartment informs on the proper orientation when inserting the batteries.
- Re-assembly is made in reverse order.

☞ *For easy assembly, please ensure that the battery cover is not pressed down (e) before it is inserted into the bottom slot between housing and protective holster (d).*

8.2 Switching on/off

SWITCHING ON:

MENU
OK needs to be pressed briefly. Wait for the beep.

SWITCHING OFF:

MENU
OK needs to be pressed for approx. 3 s . Wait for the beep. The calibration will be memorized.

- ⊗ *When switching the gauge on a start measurement is executed, which expects the probe to be lifted. Thus do not place the probe during switch-on. Otherwise the error message **Lift probe !** will be shown accompanied by three short alarm beeps.*
- ⊗ *After **first** switch-on you may start measurement without prior calibration using the factory setup. Note the information in section 12.*

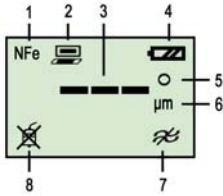
8.3 Display

Depending on the operation mode the readings, evaluations and measurement modes are displayed via various display modes.

In the following the screen contents of the display modes Standard, Statistics and Analog Representation are explained in detail. Information on possible additionally shown symbols and messages can be found in section 8.4.

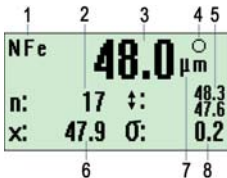
The various display modes become automatically activated and are suitable for the current operation mode. In addition, they can be selected in turn via the arrow keys: Normal -> Statistics -> Analog -> Normal -> Statistics -> ... etc.

8.3.1 Standard representation



- (1) Probe type
- (2) Symbol, if printer output is active
- (3) Reading (after switch-on and with illegal values 3 horizontal lines are shown at first, in all other cases you will see the current reading)
- (4) Battery capacity (4 levels: empty full)
- (5) Measuring indication
 - = idle in measuring mode "Single"
 - = idle in measuring mode "Continuous"
 - = measuring
- (6) Measurement unit (μm, mm, mil or inch)
- (7) Warning notice: the instrument is subjected to an interference field (see section 4): eliminate the interference field and repeat measurement!
- (8) Symbol is shown if no probe is connected

8.3.2 Statistics representation




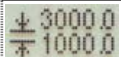
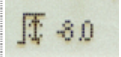
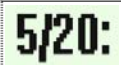




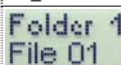
- (1) Probe type
- (2) Number of readings
- (3) Current reading (after switch-on and with illegal values 3 horizontal lines are shown at first, in all other cases you will see the current reading)
- (4) Measuring indication (as in 8.3.1)
- (5) Minimum value (bottom) and maximum value (top)
- (6) Arithmetic mean
- (7) Measurement unit (μm, mm, mil or inch)
- (8) Standard deviation according to $\sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$

8.3.3 Analog representation



- (1) Measuring range
- (2) Analog scale
- (3) Measurement and indication unit
- (4) Probe type
- (5) Current reading (digital)
- (6) Measuring indication (as in 8.3.1)

8.4 Additional symbols and abbreviations in the display

	Instrument is subjected to an interference field, measurement is not possible
	Display of the entered limit values (maximum value top, minimum value bottom)
	Display of the entered offset value
OVL	The measured value lies outside the accepted measuring range of the connected probe (remedy, if the estimated measured value lies within the valid measuring range and a false measurement or false calibration can be assumed: repeat measurement/calibration and/or reset gauge to factory settings, see section 12.2.8)
UART	Brief display indication on the initialisation of the interface
	Points to the fact that the indicated reading is one reading within a sequence of readings and is used to determine the local thickness (see section 10.2.1), the example shows "5th reading out of 20".
Fe	The connected probe is detected as Fe probe
NFe	The connected probe is detected as NFe probe
	Reading is above the upper limit (see 10.2.2)
	Reading is below the lower limit (see 10.2.2)
	The gauge has recognized a connection to a USB interface
	Power supply comes from a connected mains unit.
	If a measuring file is loaded: Information on the name of folder (top) and file (bottom)

8.5 Placing the probe

- ☞ *In order to exclude systematical and environmental or instrument caused errors with high probability, we recommend, before starting and regularly during a measurements series to perform verification measurements with known coating thickness and known substrates.*
- Place the ball tip of the probe onto the coating to be measured and hold the measuring probe **as perpendicular as possible** to the material surface. With the straight single pole probe the integrated guide sleeve helps:

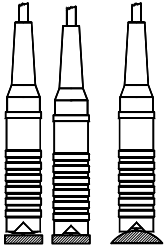


Fig. 5: Placing the one-pole probe with the aid of the guiding sleeve

8.5.1 Particularities when placing NFe micro probes

- ☞ *Due to its geometry the micro probe is particularly sensitive to tilting, i.e. when using the micro probe for measurement you need to ensure that the probe is kept perpendicular to the substrate.*

Thus, in order to gain a high repetitive measurement accuracy we recommend the use of a

- Positioning device (e.g. KARL DEUTSCH art. no. 2820.002) or a
- Positioning aid (e.g. KARL DEUTSCH art. no. 2998.001 – micro probes 0°, 2998.002 – micro probes 45°, 2998.003 – micro probes 90°),

when measurement is executed by means of the probes

- NFe micro probe 2420.201 (straight)
- NFe micro probe 2420.202 (angled for 45 °)
- NFe micro probe 2420.203 (angled for 90 °)



Fig. 6: Positioning device (left) and various positioning aids (right) for the micro probe

- ☞ *The image shows the complete unit. However, if you want to optimize the positioning device according to your specific needs, the horizontal arm of the positioning device together with a suitable probe specific holder and the pneumatic layering unit (colour marked) is available separately.*

8.5.2 Placing pressure

Select the placing pressure so a secure contact to the surface is assured, however, the does not become dented.

- ☞ *Soft coatings: Even a low placing pressure can cause surface deformations in the case of low coating hardness. With soft coatings you should place the probe with the least possible pressure. Probes with an integrated spring-loaded guide sleeve should be placed without spring assistance, if possible.*

9 Menu structure

The symbol ● in the following table denotes standard values after reset of the instrument to factory settings (see 10.5.13). Additional description to be found in section 10.5.13. The column "available in" shows which menu topics are available in which module extension of the instrument.

B Basic instrument
S Module "Statistics"
D Module "Statistics & Data Memory"

Level	Menu topics	available in
1	Calibration	B S D
2	ZeroCal	B S D
2	Cal on Foil	B S D
2	Multipoint Cal	D
2	Cal on Layer	D
2	Load Cal	D
2	Save Cal	D
2	Cal Info	B S D
2	Default Cal	B S D
3	Default Cal ok	B S D
1	Measure	B S D
2	Measuring mode	B S D
3	● Single	B S D
3	○ Continuous	B S D
3	○ Local Average	D
2	Limits	S D
3	● Off	S D
3	○ On	S D
3	Set Limits	S D
2	Offset	S D
3	● Off	S D
3	○ On	S D
3	Set Offset	S D

Level	Menu topic	available in
1	Statistics ¹	S D
2	● Off	S D
2	● On	S D
2	Delete Values	S D only, if statistics = "On"
2	Edit Values	S D only, if statistics = "On"
2	Print Values	S D only, if statistics = "On"
1	File Management	D
2	Close File	D
2	Open File	D
2	Create File	D
2	Rename File	D
2	Delete File	D
2	File Info	D
2	Create Folder	D
2	Rename Folder	D
2	Delete Folder	D
2	Delete ALL	D
3	Delete ALL ok?	D
4	Are you sure?	D
1	System Settings	B S D
2	Printer	B S D
3	● Off	B S D
3	○ On	B S D
2	Unit	B S D
3	● μm	B S D
3	○ mm	B S D
3	○ mil	B S D
3	○ inch	B S D
2	Analog Display	S D
3	● Range AUTO	S D
3	○ Range fix	S D
3	○ Range Limits	S D
3	○ Off	S D
2	Backlight	B S D
3	○ Off	B S D
3	● Normal	B S D
3	○ Bright	B S D

¹ The selected statistics mode is kept when resetting to factory setting.

Level	Menu topic	available in
2	Volume	B S D
3	○ Off	B S D
3	● Low	B S D
3	○ High	B S D
2	Keysound	B S D
3	● Off	B S D
3	○ On	B S D
2	Power Off	B S D
3	○ 10 min.	B S D
3	● Never	B S D
2	Hotkeys	B S D
3	● Off	B S D
3	○ On	B S D
2	Lock Keyboard	S D
2	Module Code	B S D
2	Set Clock	D
2	Language ^{2 3}	B S D
3	● Deutsch	B S D
3	○ English	B S D
3	○ Français	B S D
3	○ Español	B S D
3	○ Italiano	B S D
3	○ Português	B S D
3	○ Svenska	B S D
3	○ Polski	B S D
3	○ Czech	B S D
3	○ Română	B S D
2	Load Factory Set.	B S D
3	Factory Set. Ok	B S D
2	Info	B S D

² The selected language is kept when resetting to factory setting.

³ The stated languages may vary depending on customer.

10 Menu: Selections and functions in detail

10.1 Calibration

Information on the calibration modes and possible selections can be found in section 12.

10.2 Measure **B S D**

10.2.1 Measuring mode **B S D**

Determines the number of readings gained after placing of the probe.

Single: One measured value after placing of the probe.

Continuous: Continuous acquisition of readings after placing of the probe (1 reading per second approx.).

☞ *Depending on the given measurement situation it may be possible that the last reading in measuring mode "Continuous" is shown only just before lift-off of the probe.*

Local average: only with module **D**
With this testing method the significant test field⁴ is subdivided into small individual test fields, on which in each case a given number of measurements is carried out (example in Fig. 7: n1 to n9). For these individual test fields the arithmetic mean value is calculated (example in Fig. 7: individual mean values X1 to X12) and indicated as final measured value and is stored – if the data memory is activated.

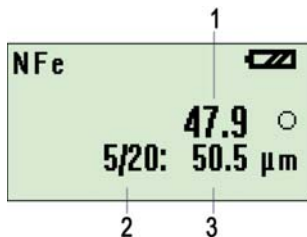
n1 n4 n7 n2 X1 n8 n3 n6 n9	n1 n4 n7 n2 X2 n8 n3 n6 n9	n1 n4 n7 n2 X3 n8 n3 n6 n9	n1 n4 n7 n2 X4 n8 n3 n6 n9
n1 n4 n7 n2 X5 n8 n3 n6 n9	n1 n4 n7 n2 X6 n8 n3 n6 n9	n1 n4 n7 n2 X7 n8 n3 n6 n9	n1 n4 n7 n2 X8 n8 n3 n6 n9
n1 n4 n7 n2 X9 n8 n3 n6 n9	n1 n4 n7 n2 X10 n8 n3 n6 n9	n1 n4 n7 n2 X11 n8 n3 n6 n9	n1 n4 n7 n2 X12 n8 n3 n6 n9

When starting this menu topic first of all the number of measurements per individual test field is entered (n_x).

Up to 20 measurements per individual test field are possible.

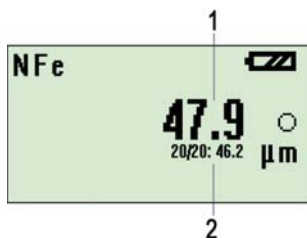
Fig. 7: Significant test field and allocation into individual test spots

⁴ the significant test field represents a surface field, that is typical for the object of measurement with regard to the substrate qualities as well as the coating application and coating specifications



Display with data acquisition:

- (1) Mean value of a individual test field (in each case the last determined value)
- (2) Measurement counter for the individual measurements in format n/m where
 n = current measurement
 m = number of measurements per individual test field
- (3) = current individual value



Display after acquisition of the mth measured value:

- (1) Mean of the individual test field
- (2) Last individual reading before calculation of the mean value

10.2.2 Limits **S D**

Limits can be used to check whether the readings lie within a selectable bandwidth. If limit monitoring is selected to ON excess of limits is indicated acoustically and optically:

acoustically: Double tone instead of single tone during measurement
Symbol indication: > when exceeding the upper limit
< when dropping below the lower limit

Off Monitoring of limits is selected to OFF

On Monitoring of limits is selected to ON

Set limits Setting the limits (sequence: minimum -> maximum):



With the graphical indication of readings (see section 10.3) the limits are shown as dotted lines.

Fig. 8: Graphical indication of readings



With the analog display (see 8.3.3) the limits can be used as upper and lower scale end values.

Fig. 9: Analog display

10.2.3 Offset **S D**

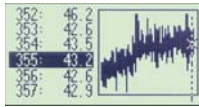
The offset value decreases or increase the measured value for a selectable amount.

Off Offset is selected to OFF

On Offset is selected to ON

Set Offset Setting the offsets

- Off** The statistics display is selected to OFF
- On** The statistics display is selected to ON (screen contents see section 8.3.2).
- Delete Values** The values taken for statistical evaluation become deleted.
- Edit Values** The values for the statistics evaluation are displayed as list with consecutive number. An additional window shows the graphical course of the readings.



The position of the measured value currently selected by the arrow keys is indicated by means of a dotted line.

Fig. 10: List of measured values with graphical course of readings

The marked reading can be deleted:

To do so press the key **MENU** **OK** and confirm the subsequent question by a repeated pressing of **MENU** **OK**. Use **ESC** if you want to quit the delete process without change of data.

Print Values

By means of this menu topic you can export the currently underlying measured values for statistics evaluation via the interface line (this is analogous to the example in 10.5.1).

- ☞ *When printing the statistics contents the print head shows the word "Statistics" instead of the folder and file name.*

10.4 File Management **D**

Close File

The currently opened file of readings is getting closed and storing of readings is terminated.

Open File

This item is used to open available file of readings. This will transfer the stored data to the working memory and then they are available – for instance - for statistics evaluation and printouts.

- ☞ *When opening a file the display mode "statistics" automatically is selected (see 8.3.2). Use the arrow keys to change to the display mode "Standard" (see section 8.3.1) if you want to indicate information on the folder and file name of the currently loaded file.*

When opening a file the contained calibration is loaded. With subsequent commencement of measuring the new readings will be appended to the already existing readings using the loaded calibration.



Fig. 11: Memory structure


Stored files are displayed together with their superior folders. Use the arrow keys to select the desired file.

- ☞ *At a glance the small figures inside the symbols for folder and file show the number of subordinate files and/or the number of readings in the assigned file.*
- ☞ *Also files which have been saved via the menu topic "Save Cal" (see section 12.2.6) are listed here. Please note that calibration files may contain no readings.*




Folder	Folder 2
File	File 01
Date	01.06.07 11:36
Measures	5 (NF<)
Probe	2442.1300 10000






Fig. 12: File info

At first, when selecting a file via  an information window containing specific file information on folder, file, storing date and time, number of available readings, probe type (Fe/NFe),

probe article no. and probe serial number is shown.

Striking the key  once again will open the file.

- Create File** Via this topic you can create a file to store readings. Use the alphanumeric input to specify a file name. When confirming the file name via OK the file is created in the currently opened folder.
- Rename File** After selection of a file the alphanumeric input window will show where the current filename is suggested by default and can be renamed. When confirming via OK the file gets stored under the altered name.
- Delete File** This topic is used to delete one file of readings from the memory of the instrument. After invoking of this menu topic you can use the arrow keys to select the file to be deleted.
-  *Deletion of files only can be executed if all files are closed. If required select the menu topic "**Close File**" to do so.*
- File Info** The file info as mentioned above under "Open File" can be shown here separately.
- Create Folder** After input of a folder name via the alphanumeric input you should strike OK to add a new folder to the memory structure.

- Rename Folder** After start of this menu topic all available folders are displayed. Use the arrow keys to select the folder to be renamed. Renaming is executed via the alphanumeric input window and terminating confirmation by OK.
- Delete Folder** Use the arrow keys to select the folder to be deleted and confirm the selection by striking . Since deletion of a folder will also delete all files contained in this folder you need to confirm the security message "**Delete incl. Files**" by striking OK. Use the key  if you want to cancel the deletion process.
- Delete ALL** This menu topic can be used to delete the complete memory of measured values. After start the security question "**Delete ALL ok?**" is shown, which is confirmed when striking the key . However, only if the repeated security question "**DELETE ALL?**" is confirmed via the key  the complete memory is deleted. Use the key  if you want to cancel the deletion process.

10.5.1 Printer

In addition to the display indication the readings can be exported via the interface (see section 6, control 5), e.g. for PC⁵ or printer).

On: In addition to the display the readings with print head and print foot is exported via the data interface (5).
Transfer format: 4800 Bd, 8 data bits, no parity, 1 stop bit.

```

KARL DEUTSCH WUPPERTAL
---- LEPTOSKOP 2042 ----

Driller/Shank

Limits:
      48.8 um
      58.8 um

Offset:
      -1.8 um

-----

No:  Value:
  1:  47.2 um <
  2:  47.6 um <
  3:  48.1 um
  4:  48.0 um
  5:  48.6 um
  6:  48.5 um
  7:  48.6 um
  8:  48.2 um
  9:  52.6 um >
 10:  53.6 um >
 11:  53.4 um >

Statistics
Anz  :    11
σ    :   49.5 um
σ(n-1):   2.4 um
Min  :   47.2 um
Max  :   53.6 um

---- LEPTOSKOP 2042 ----
    
```

☞ Automatic output of the **print head** after activation of the interface line via the menu topic System Settings -> Printer -> On

The output of readings comes with
a) consecutive number (1 to 9999)
b) measured value
 (dot = decimal separator)
c) Unit (um, mm, mil, inch)

☞ Automatic output of the **print foot** when switching the instrument off and after deactivation of the interface line via the menu topic System Settings -> Printer -> Off.

Fig. 13: Example printout

Off: Interface output is switched off.

10.5.2 Unit **B S D**

Select the unit which is used by the readings on the display and for output via the interface line.

Selections: μm (= 1/1000 mm), mm, mil (1/1000 inch) and inch.

⁵ More information on the data output format can be found in section 14.

10.5.3 Analog Display **S D**

Select the analog display, if you want to watch the measurements on a conventional analog indication scale. The digital reading will be shown additionally.

☞ Use the arrow keys to switch in turn between the digital indication of readings (statistics or normal display) and the analog display: Normal display -> statistics display -> analog display -> normal display -> statistics display -> ... etc.

Range AUTO The scale division is automatically selected to match the measured value.

Range Fix Based on the first measurement after start of this menu topic a suitable display range is chosen. The start and end values of this become fixed as scale start and end.

Range Limits The scale limits are equal to the current range limits (see 10.2.2).



As an example the opposite image shows the Analog Display in mode "Range Limits". The current mode is shown top left in the display:

Fig. 14: Analog display

Auto: Range AUTO
Fix: Range Fix
Limit: Range Limits

10.5.4 Backlight **B S D**

Controls the backlight of the display.

Off: The backlight intensity is at its minimum. With dark environment the residual intensity is sufficient to activate the backlight via this menu topic.

Normal: The backlight is on with brightness.

Bright: The backlight is active at its maximum intensity.

If options **Normal** or **High** are selected: After about 60 s idling the backlight is switched off. A measurement or a keystroke will switch the backlight on again.

- ☞ *Due to the higher current consumption the battery lifetime of the LEPTOSKOP 2042 is reduced with active backlight.*
- ☞ *If the interface is connected to an external USB socket, the USB power line is used to supply the instrument. In this case the backlight will not switch off.*
- ☞ *The selected level of backlight which is active during switch-off of the instrument becomes memorized and is restored when it is switched on again.*

10.5.5 Volume **B S D**

For acoustic monitoring you can select whether and at which volume signal tones are generated.

Off: no signal tone

Low: low signal tone

High: high signal tone

10.5.6 Keysound **B S D**

For acoustic feedback you may select whether a keystroke is accompanied by a signal tone or not.

Off: Keystroke without signal tone.

On: Striking a key generates a signal tone.

10.5.7 Power Off **B S D**





In order to extend the battery lifetime you may select whether the instrument will switch-off after a certain period without actuation of a key and without measurement.

10 Min: The instrument will switch-off after 10 min idling.

Never: The instrument will not switch-off.

10.5.8 Hotkeys **B S D**

If the menu topic **Hotkeys** is activated you can use the key **ESC** during measurement for direct access to relevant menu topics, depending on the display mode.

Display Mode (examples)	Hotkey	Direct access to the menu topics:
<p>Standard</p> 		ZeroCal Cal on Foil Multipoint Cal Cal on Layer Load Cal Save Cal Cal Info Default Cal
<p>Statistics</p> 		<input checked="" type="radio"/> Off <input type="radio"/> On Delete Values Edit Values Print Values
<p>Analog</p> 		Range AUTO Range Fix Range Limits

10.5.9 Lock Keyboard^{6 7} **S D**

You can enter an instrument-specific 6 digit code number to prevent the instrument settings from being altered via the keyboard. If the keyboard lock is active, you will need to enter the code to call the menu. When entering the code number again, the keylock is suspended again.

10.5.10 Module Code⁸ **B S D**

By entering the module code you are capable of unlocking an additionally purchased software extension. If you have purchased the software extension together with the instrument it is activated ex works.

10.5.11 Set Clock **D**

Here the alphanumeric input window can be used to set the internal clock, the time and data information of which is stored – for instance – in the file of readings.

Format of the time: ss:mm

Format of the date: DD.MM.YYYY

10.5.12 Language **B S D**

Select one of the available operating languages⁹:

- Deutsch
- Français
- Italiano
- Svenska
- Czech
- English
- Español
- Português
- Polski
- Română

☞ *Once the language is selected it remains selected even after reset to factory settings (as described in section 10.5.13).*

10.5.13 Load Factory Set. **B S D**

You can recall the factory settings, which are selected ex works when the instrument is delivered. The factory settings contains default menu topics (see section 9).

Factory Set. Ok: Strike OK to load the factory settings

⁶ Only with software extension "Statistics & Data Memory"

⁷ The code for Lock Keyboard is specific to the instrument and equal to the unlock code for the software extension (Module Code). On delivery it is recorded in a separate document.

⁸ The module code is specific to the instrument. On delivery it is recorded in a separate document.

⁹ The available language may differ depending on instrument and/or customer.

10.5.14 Info **B S D**

This info window shows specific information on your LEPTOSKOP 2042.

Menu topic		Meaning
Device	2042.001	Distinct instrument type number
S/N	10000	Serial number
Placings	XXXXX	Number of placings of the probe since delivery of the instrument (contains measurements for final inspection at the manufacturer's site)
Operating Hours	XXX.XX	Operating hours since delivery (contains operating hours for final inspection at the manufacturer's site)
SW-Ver	XXXX	Included software version
Memory	xxxx xxxx	Internal information

11 Do I need to calibrate manually?

In addition to the default ex works calibration it is possible to calibrate manually if the measurement accuracy which can be obtained by means of the default ex works calibration¹⁰ is not sufficient for the given application.

Checking for sufficient measurement accuracy:

You will need a reference sample, e.g.

- a calibration foil and the uncoated substrate or a
- permanent coating of known thickness on the material which will be used for actual measurement (e.g. coating sample)

Measure the coating thickness of the reference sample and decide, whether the measurement accuracy which can be obtained by the default ex works calibration is sufficient for the application.

If the required measurement accuracy can not be obtained by means of the default ex works calibration you can execute a manual calibration (see following sections). Further information on the calibration can be found in the respective standards:

- NFe probes:
DIN EN ISO 2360 for eddy current measurement.
- Fe probes:
DIN EN ISO 2178 for measurement according to the magnetic-inductive principle.
- NFe/Fe combined probes: DIN EN ISO 2360 and DIN EN ISO 2178, depending on the measuring method.

¹⁰ Reset of the instrument to default calibration: see section 12.2.8

12 Calibration

12.1 General notes on calibration

- By manual zero and/or foil calibration, as described in the following chapters, a high measurement accuracy can be achieved which to a great extent is not influenced by the shape and type of the substrate. For zero calibration you require the uncoated substrate and for foil calibration a calibration foil of known thickness.
- The calibration value is the mean value of all measurements executed. Thus the calibration is the more accurate the more measurements have been executed, since this, for instance, will reduce the possible influence of any surface roughness.
- When switching the instrument off, the calibration is maintained!
This means: If there was a manual calibration before switching-off it will be used again after switch-on. This enables immediate continuation of the measurement on the same material. However, if you are going to use different material after switch-on (different shape, different material, different location of measurement) you need to re-calibrate.
- With complicated geometry (e.g. round material, hollow bodies) you should not use the ex works default calibration. In these cases you should always execute a manual calibration. Also with non-flat material you need to calibrate manually.

12.2 Calibration Modes

12.2.1 ZeroCal (Calibration on uncoated specimen) **B S D**

When to use?

- If the default calibration ex works is not accurate enough.
- If the substrate has been exchanged compared with the last zero calibration.
- If the probe is exposed to high mechanical stress and you want to avoid false readings caused by deformation of the probe tip (e.g. by abrasion).

How to proceed after initiation of menu topic "ZeroCal":

- The instrument will change to measurement operation in order to acquire calibration values.
- Place the probe onto the **uncoated** substrate. Execute some measurements in order to minimize the placing inaccuracies. In each case the last measured value can be deleted with ESC.

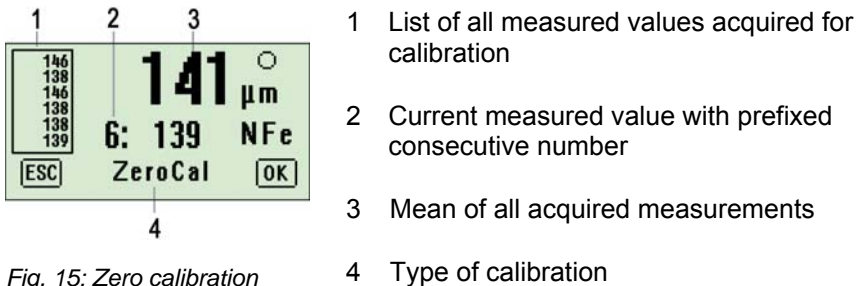


Fig. 15: Zero calibration

- Press **MENU** **OK** if you want to confirm the ZeroCal measurements. In each case the last measured value can be deleted with **ESC**.
 - Subsequently the instrument returns to measurement operation based on the calibration executed for "ZeroCal".
- ☞ *ZeroCal will delete other possibly available calibrations (e.g. Cal on Foil, Multipoint Cal). Therefore, after ZeroCal, please check the measurement accuracy as described in section 13.2. If the measurement accuracy isn't sufficient, you should repeat possibly required, alternative calibrations again (see section 12.2.2 ff).*

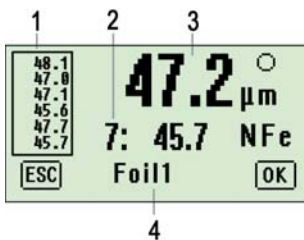
12.2.2 Cal on Foil (Calibration on zero and foil) **B S D**

When to use?

- If the default calibration ex works is not accurate enough.
- In addition to the zero calibration, if you want to execute a two point calibration (zero and foil) to achieve higher measurement accuracy (see Technical Data).
- If the substrate is the same compared with the last zero calibration, however the measuring range is changed.

How to proceed after initiation of menu topic "Cal on Foil":

- The instrument will change to measurement operation in order to acquire calibration values for the zero calibration. Execute the zero calibration as described in section 12.2.1. Confirm the zero calibration via **MENU OK**.
- Put calibration foil onto the **uncoated** substrate.
- Place probe on the foil (thickness of foil = nominal value). Execute some measurements in order to minimize the placing inaccuracies. A current measured value can be deleted with ESC.



- 1 List of all measured values acquired for calibration
- 2 Current measured value with prefixed consecutive number
- 3 Mean of all acquired measurements
- 4 Type of calibration

Fig. 16: Cal on Foil

- Press **MENU OK** if you want to confirm the foil measurements. In each case the last measured value can be deleted with **ESC**.
- Subsequently a request on the nominal value of the used foil is shown. Input as described under section 7.2.1.
- After confirmation by striking **MENU OK** the instrument returns to measurement operation based on the calibration executed for "Cal on Foil".

12.2.3 Multipoint Cal (Multiple point calibration) **D**

When to use?

- If the calibration modes "Default Cal", "ZeroCal" and/or "Cal on Foil" will not result in a sufficient accuracy across the entire range of coating thickness to be expected.
- Using Multipoint Cal you will gain increased accuracy with measurements on specimen with complicated geometry and/or a wide range of varying coating thickness to be expected.
- ☞ *The calibration mode "Multipoint Cal" needs at least two calibration references: Either the uncoated substrate (for ZeroCal) plus one foil of known thickness or two foils of known thickness.*

How to proceed after initiation of menu topic "Multipoint Cal":




- At first the instrument will change to the measuring display requesting the first calibration. This may be a zero calibration or a foil calibration. Therefore the type of calibration is denoted "Zero / Foil1" (Pos. 4).
- ☞ *The nominal value for a calibration on uncoated substrate (zero calibration) is 0.*
- After you have terminated the first calibration via the key **MENU OK** the gauge automatically shows a window for executing the follow-up calibration with the aid of another foil. Here, as well, the type of calibration is denoted as "Zero / Foil1".
- When finishing the second calibration the request "Next Foil ?" can be used to decide whether to execute a further calibration. Strike **MENU OK** if you want to continue with the Multipoint Cal or strike the key **ESC** if no further calibration is desired.
- ☞ *When proceeding with the Multipoint Cal the type of calibration (pos 4) will change to "Foil2, Foil3 etc. Up to 9 calibration points are possible.*
- After confirmation by striking **MENU OK** the instrument returns to measurement operation based on the calibration executed for "Multipoint Cal".

12.2.4 Cal on Layer (Calibration on unknown coating)

When to use?

- Only with measurements on Fe material.
- If you want to know the thickness of a layer but you aren't able to execute a zero calibration on the uncoated reference material (e. g. if the coating needs to remain intact and no uncoated reference substrate is available).

How to proceed after initiation of menu topic "Cal on Layer":

- At first the instrument will change to the measuring display requesting the first measurement on the unknown layer.
- Execute several measurements on the unknown layer (indicated type of calibration: "Cal-X") . Confirm the measurements by striking the key .
- Put a foil of known thickness onto the unknown coating of the material.
- Execute several measurements on the foil (indicated type of calibration: "Foil"). Confirm the measurements by striking the key .
- Enter the thickness of the used foil when the request for nominal value appears.
- After confirmation by striking  the instrument returns to measurement operation based on the calibration executed for "Cal on Layer".
- Follow-up thickness measurements refer to the distance of the layer to the non-accessible material surface.

12.2.5 Load Cal **D**

Stored calibrations can be loaded to become the current calibration.

- ☞ *Calibrations are contained in special calibration files (see section 12.2.6) and, as well, in normal files of readings. They can be loaded from both file types.*

12.2.6 Save Cal **D**

Current calibrations can be stored in calibration files separately from any readings.

- ☞ *When storing calibrations no readings are stored together with them.*
- ☞ *Calibration files are stored in the same folder structure as files of readings are. Thus, when storing calibration files it is recommended to chose a descriptive file name, e.g. "Calibration 13" or "Cal Block 13A", so you can make out the type of file already by the name list of calibration files and/or files of readings.*

12.2.7 Cal Info **B S D**

Information on the current calibration can be shown via this menu topic.

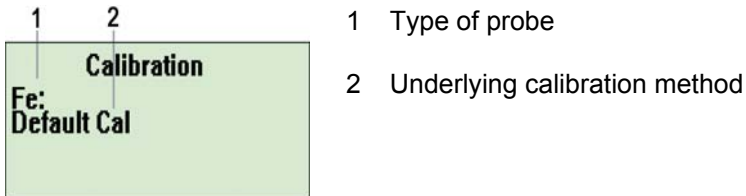


Fig. 17: Info window on the current calibration

12.2.8 Default Cal **B S D**

When to use?

- Measurements on standard material (if in doubt please check the possible measurement accuracy as described in section 13.2).
- Selection for check of the measurement accuracy of the instrument (see section 13.2).

How to proceed after initiation of menu topic "Default Cal":

- Strike **MENU OK** again. A safety request will appear: "Default Cal ok". Only if this request is confirmed by striking **MENU OK**, the instrument will change to measurement with underlying Default Cal. Use **ESC** if you want to cancel the reset to Default Cal.

☞ *The accuracy of the default calibration depends on the proper condition of the probe tip. The probe tip is subject to tear and wear and is affected by the conditions of measurement. Thus the built-in default calibration should be checked in regular time intervals (see section 13.2).*

13 Notes on measurement and calibration

13.1 Influences on measurement accuracy

The accuracy which can be obtained by the instrument is affected - amongst others - by the following factors:

• coating thickness	• edge effect
• curvature of the surface	• roughness of the surface
• foreign objects	• contact pressure and orientation/inclination of the probe
• conductivity of the coating	

Additional method-specific factors are:

Magnetic-inductive method (DIN EN ISO 2178)	Eddy current method (DIN EN ISO 2360)
• magnetic qualities and thickness of the substrate	• electric qualities and thickness of the substrate
• machining orientation of the substrate	• temperature effects
• magnetic fields and residual magnetism	• intermediate layer
• conductivity of the coating	

13.2 Regular check of the measuring means

Measuring means like the instrument with accompanying calibrating standards are subject to tear and wear so the measuring accuracy may be affected.

It is for this reason that the measuring means should be subjected sufficiently often to a regular check in order to verify the faultless function and adequate accuracy.

The check can be executed by means of a reference coating, e.g. ...

- a calibration foil on the test block Fe or NFe or
- a permanent coating of known thickness on known substrate (e.g. coating sample)
- Use the menu items Calibration -> Default Cal -> Default Cal ok to recall the default calibration of the LEPTOSKOP 2042.
- Measure the reference coating

If the permissible measurement inaccuracy is exceeded (see Technical Data, section 18) it is recommended to execute an instrument check at KARL DEUTSCH's in order to re-calibrate the LEPTOSKOP 2042.

14 Format of the printer output

In order to facilitate further processing it is possible to transfer the measuring data via the serial interface directly into a PC. For instance, you can utilize the standard transfer program of the operating system (e.g. Hyper Terminal of a Windows OS).

Transfer format: 4800 Bd, 8 data bits, no parity, 1 stop bit.

```
CRLF
KARL DEUTSCH WUPPERTALCRLF
---- LEPTOSKOP 2042 ----CRLF
CRLF

•••1:••••757.2•umCRLF
••19:••••0.1474•mmCRLF
••35:••••30.06•milCRLF
••52:••••0.0543•inchCRLF

CRLF

---- LEPTOSKOP 2042 ----CRLF
-----CRLF
CRLF
```

Automatic output of the **print header** after activation of the interface by means of the menu topics Settings->Printer->On
CRLF = Carriage Return and Line Feed

Output lines of readings will use the following format each (examples):

- 1) 3 space characters if there is 1 figure as consecutive number, 2 space characters if there are 2 figures as consecutive no., 1 space characters if there are 3 figures as consecutive no.
- 2) consecutive number from 1 to 999, afterwards restart at 1
- 3) 3 space characters
- 4) readings use the following format each: xxxx.x µm, xx.xxx mm, xxxx.xx mil or xx.xxxx inch. Non-significant leading zeros are replaced by space characters (the example shows •).
- 5) space characters and measuring unit
- 6) the characters > or < to denote excess of limits¹¹

Automatic output of the **print footer** after de-activation of the interface by means of the menu topics Settings->Printer->Off
CRLF = Carriage Return and Line Feed

15 Cleaning of the instrument

The front panel foil keypad is insensitive to soiling and can easily be cleaned as well as the rest of the housing is.

Soiling should be removed with a cloth immediately after occurrence.

In most cases a cloth soaked with a smooth cleaning agent is all that is required.

- ☞ *Never use cleaning agents which will dissolve plastics or which are mixed with sand or other abrasive materials, which might scratch the surface of the display window.*

Strictly avoid mechanical abrasion, scratching or scraping when cleaning the instrument.

Please also ensure that no humidity soaks into the housing during cleaning.

¹¹ only with software extension "Statistics & Data Memory"

16 Disposal

- ⚠ After the end of service life, the device must be disposed expertly. This means that the battery must be removed before and disposed separately corresponding to the legal directives. If in doubt, please ask KARL DEUTSCH.

17 Declaration of conformity

- CE** This appliance has been developed and manufactured with regard to its electromagnetic compatibility for use not only in industrial but also in residential, commercial and trade premises and in small businesses in accordance with harmonised standards.

Thus the appliance complies with the most important protection standards of the Electromagnetic Compatibility Directive (89/336/EEC) and the German Electromagnetic Compatibility Act of 9 November 1992 (as amended from time to time).

18 Technical Data

Display

Display type
Face

LCD graphics module 128 x 64 points
48 x 24 mm² approx.

Acquisition of measuring data

Measuring method

FE measuring:
magnetic-inductive procedure (DIN EN ISO 2178)
NFe measuring:
eddy current method (DIN EN ISO 2360)

Measuring performance
(continuous mode)

1 reading per second approx.

Measuring ranges

Fe:
Standard probe: 0 - 3000 µm
Standard probe special: 500 µm – 20,000 µm
Micro probe: 0 - 500 µm
Two pole probe: 500 µm - 12500 µm

NFe:
Standard probe: 0 - 1000 µm
Standard probe special: 0 - 3750 µm
Micro probe: 0 - 500 µm

Calibration

Zero, one point and two point calibration on uncoated substrate, multiple point calibration, calibration on coated substrate (if no uncoated material is available) or default calibration

Resolution

for coatings < 100 µm: 0.1 µm
for coatings < 1000 µm: 1 µm
for coatings < 10000 µm: 10 µm
for coatings > 10000 µm: 100 µm

Measuring inaccuracy after two point calibration on test blocks 2815.XXX

Measuring inaccuracy depends on
1. substrate
2. calibration method
3. calibration points

For probe types:

Standard probe Fe/NFe
Micro probe Fe/NFe
Standard probe special NFe

... the following values are true:
coating < 100 µm: 1 % +/- 1 µm
coating > 100 µm: 1..3 % +/- 1 µm
coating > 1000 µm: 1.5 % +/- 10 µm

For probe types:

Two pole probe
Standard probe special Fe

... the following values are true:

coating > 500 µm: 1..3 % +/- 10 µm
coating > 10,000 µm: 1..5 % +/- 100 µm

Operating

Type
Languages

Menu guided
German, English, French, Spanish, Italian, Portuguese¹²

INPUTS and OUTPUTS

Serial PC/printer interface

4-pin LEMO1-socket for data cable 1657.311 (RS232) and 1657.312 (USB)

Data format: 4800 Baud, 8 data bits, 1 stop bit, no parity

Probe

4-pin LEMO1-socket to connect all LEPTOSKOP probes of the 2442.xxx series

Charger socket

Via USB cable 1657.312

Tone generator

Signal tone for confirmation of measured values (single measurement), for limit monitoring and keystroke detection

MISCELLANEOUS

Measuring systems

selectable µm, mm, mil and Inch

Date and time

Real-time clock, battery buffered

Coupling control

Continuous measurement: optical by symbol in the display

Single measurement: optical and acoustical

Backlight

Built-in LCD backlight (white, switchable on/off)

Memory

Readings

max. 999 readings per file,
total max. 9999

less 100 readings approx. per created file

Number of files

max. 140

¹² There is an ongoing broadening of the selection of available languages and may depend on customer's request.

POWER SUPPLY

With rechargeable batteries
operating time
With primary cells

2 pcs. NiMH batteries (size AA, Mignon)
45 h approx. (w/ brand new cells)

Operating time:
Continuous measuring w/o backlight
Continuous measuring w/ backlight
Indication of battery capacity

w/ alkali-manganese primary cells
90 h approx.
45 h approx.
4-step battery level indicator
Acoustic alarm approx. 2 to 4 hours prior to undervoltage status
automatic cut-off with undervoltage

Permissible ambient conditions

Operating temperature
Storage temperature

0 °C to +45 °C
-20 °C to +60 °C w/ built-in batteries
0 °C to +45 °C w/ batteries removed

Dust and humidity

Protective class IP 40 (protection against penetration of particles ≥ 1 mm)

Housing

Size (HxWxD) (incl. holster)
Weight
Material

81 mm x 121 mm x 32 mm
175 g w/o batteries, 220 g w/ batteries
ABS, black - holster TPE

Keypad

Execution

4 keys, foil keypad