ElektroPhysik

Operating instructions

Coating thickness gauges

MiniTest 2500 and MiniTest 4500

Version 1.0 14.06.2018
Gauge software Version: from 1.0.1
Sensor Software: from 1.0

Subject to technical change without notice.

ElektroPhysik
Dr. Steingroever GmbH & Co. KG
Pasteurstr. 15
50735 Cologne
Germany
Tel.: +49 221 752040
Fax.: +49 221 7520467
Internet: http://www.elektrophysik.com/
Mail:: info@elektrophysik.com

Index

1. Introduction 8
2. First steps 9
2.1 Inserting batteries and connecting the sensor 9
2.2 Operation of the gauge 10
3. Description of the measuring system 11
3.1 Gauge 11
3.1.1 General 11
3.1.2 Front view 11
3.1.3 Operating keys 12
3.1.3 Interfaces 12
3.1.4 Power supply 12
3.1.4.1 Batteries and rechargeable batteries 12
3.2 Sensors 13
3.2.1 Sensors of the MiniTest 1100 – 2100 - 3100 - 4100 series 13
3.2.1.1 Adaptation of sensor types F05, F1.6, F3, F1.6/90, F2/90, F10, F20, N.08 Cr, N02, N1.6, N1.6/90, N2/90, CN02 and FN1.6, FN1.6P, FN 1.6/90, FN2/90 13
3.2.1.2 Adaptation of sensor types N10, N20 and N100 14
4. Measuring, Storage and Data Processing in DIRECT or APPL-BATCH mode 15
4.1 Switch on / start-up screen 15
4.2 Structure of the APPL-BATCH system 17
4.3 Switching APPL-BATCH mode on / off 18
4.4 Displaying the number of active APPL-BATCH 19
4.5 Selection of an APPL memory 19
4.6 Selection of a BATCH memory 19
5. Measuring 20
5.1 Important Notes on Coating Thickness measurement 20
5.1.1 Interpretation of readings 20
5.2 Basic settings 20
5.3 Preparing measurement 21
5.3.1 Calibration 21
5.4 Taking readings 21
5.4.1 Taking readings without using the sensor stand 21
5.4.2 High-precision stand 22
5.4.3 Duplex coating systems 22
5.5 Errors during measurement 22
5.6 Measurement on high temperatures using high-temp sensors 22

6. Calibration 24
6.1 General notes on calibration 24
6.2 Calibration methods 25
6.2.1 Factory pre-setting 25
6.2.2.1 Zero Calibration 25
6.2.2.2 Two-point Calibration 25
6.2.2.3 Multi-point Calibration 25
6.2.2.4 Two-point Calibration without zero 26
6.2.2.5 Calibration through a coating (CTC) 26
6.4.3.1 Calibration of FN-type sensors 26
7. Calibration 27
7.1 Activate factory settings 27
7.2 Zero Calibration 27
7.3 Two-point calibration (zero setting plus one calibration foil) 28
7.3 Multi-point calibration (zero setting plus up to four calibration foils) 29
7.5 Two-point calibration using two calibration foils without zero calibration 30
7.6. Calibration Through the Coating 33
7.7. Sensors N10 and N20 34
7.7.1 Standardization (Acquisition of Infinite Value) 34
7.7.2 Two-point calibration (zero setting plus one calibration foil) 34
7.7.3 Elimination of dielectric interferences of the coating material 35
7.8 N100 Sensor 35
7.8.1 Standardization (Acquisition of Infinite Value) 35
7.8.2 Two-point calibration (zero setting plus one calibration foil) 36
7.8.3 Elimination of dielectric interferences of the coating material 36
7.9 Sensor F20 37
7.10 Sensor F50 37
7.11 Tube sensors F1.6/90, F2/90, N1.6/90 and N2/90 38
7.12 Chrome Coatings on Copper 38
7.13 Sensor CN02 38
7.14 Recalibration in an APPL memory line 38
7.15 Shot-blasted and rough surfaces 40
7.15.1 General 40
7.15.2 Method A (roughness Rz > 20µm) 40
7.15.3 Method B (roughness Rz < 20µm) 40
7.15.3 Method C Calibration with two calibration foils of different thickness 40
8. Data Management 41
8.1 Batches 41

8.1.1 General 41
8.2 Offset 41
8.3 Block size 41
8.4 Upper limit / Lower limit 41
8.5 Single values / Continuous measurement mode 42
8.6 Measuring with statistics 42
8.7 Taking a series of measurement with statistical calculation 43
8.8 Deleting outliers or erratic readings 43
8.9 Storage capacity overflow 44
8.10 Display or print-out of a series of measurements 44
8.10.1 Single value statistics 44
8.10.2 Block value statistics 45
9. Deletion 46
9.1 Deleting the last reading 46
9.2 Deleting statistical values 46
9.4 Deleting a series of measurements including limits and statistics within an APPL-BATCH memory 46
9.5 Deleting limit values within an APPL-BATCH memory 46
9.6 Deleting all series of measurements incl. statistics, limits and calibration values of an APPL memory 47
9.7 Total Reset 47
10. Data output and transfer 48
10.1 Printing data 48
10.2 Data transfer to PC (terminal program) 48
10.3 Read out data via a PC 49
11. Further functions 50
11.1 Initialization 50
Initial functions and settings 50
11.1.1 Total Reset 50
11.1.2 LCD Segment Test 50
11.2 Gauge configuration 50
11.2.1 Blockgröße 50
11.2.2 Display illumination 51
11.2.3 Keypad illumination 51
11.2.4 Acoustic signal 51
11.2.5 Time and date stamp 51
11.2.6 Time and date 51
11.2.7 Measuring unit: ‘metrical’ - Inch’ (imperial) 52
11.2.8 Automatic data transfer in continuous mode 52

11.2.9 Timestamp 52
11.2.10 Setting of display colours for measurements 52
11.2.11 Setting of display colours for readings above preset limits 53
11.2.12 Setting of display colours for readings below preset limits 53
11.2.13 Optional alarm output – Setting of signal length of the measuring value 53
11.2.14 Optional alarm output – Setting of signal length for readings above limits 53
11.2.15 Optional alarm output – Setting of signal length for readings below limits 53
11.2.16 Configuration of the optional foot switch 53
11.2.17 Pairing of a BLUETOOTH printer 53
11.2.19 Format of logged measuring values 54
11.2.20 SENSOR INIT 54
11.2.21 „POWER SUPPLY“ Setting 54
11.2.22 „POWER OFF“ Switch off time 55
11.2.23 SYSINFO 55
11.2.24 Table of basic settings for MiniTest 4500 56
11.2.25 Table of basic settings for MiniTest 2500 57
12. Accessories 58
12.1 General 58
13. Care and maintenance 59
13.1 Care 59
13.1.1 Using NiMH rechargeable batteries 59
13.2 Maintenance 60
14. Technical data 61
14.1 Gauge specification 61
14.2 Sensor specifications 62
14.3 Standard supply 65
14.3.3 Coating thickness gauge MiniTest 2500/ 4500 with interchangeable sensor 65
14.3.4 Interchangeable sensors for MiniTest 2500/4500 65
14.4 Accessories 66
15. Annexe 67
15.1 Error messages and trouble shooting 67
15.2 Statistical terms 68
15.3 Safety notes 69
15.4 Declaration of conformity according to EU directive 70
15.5 Return of used equipment 70
15.6 Service-Adressen 71
16. Change history 72
17. Index 73

1. Introduction

The new coating thickness gauges MiniTest 2500 and MiniTest 4500 combine high precision modern measuring technique and a classic handling concept.

Coating thickness gauges MiniTest 2500 and MiniTest 4500 measure non-destructively according to the magnetic induction or the eddy current principle depending on the sensor type connected to the gauge. The gauges comply with the following standards:

DIN EN ISO 1461	ASTM B244	AS 3894.3-2002
DIN EN ISO 2064 DIN EN ISO 2178	ASTM B499	SS 18 41 60
DIN EN ISO 2360	ASTM D7091	SSPC-PA 2
DIN EN ISO 2808	ASTM E376-03	
DIN EN ISO 19840		

The portable gauge is used for quick and precise non-destructive coating thickness measurement in the field of industrial corrosion protection and is used by manufacturers and end users of corrosion protected products, by authorities and inspectors,in electroplating and paint shops as well as in chemical industry, automotive production, ship building, aviation and tool and machine engineering.

MiniTest coating thickness gauges are equally qualified for use in a laboratory as well as in rough industrial environments or construction sites thanks to their particularly rugged housing designed in protection class IP65.

A broad selection of measuring sensors is available for the MiniTest 2500/4500 line of coating thickness gauges allowing to handle standard applications as well as more complex measuring tasks as for example measurement in tubes or thick coatings up to 100mm coating thickness.

The intelligent MiniTest-sensors also cope with sophisticated applications such as measurement of objects with unusual geometry or coatings with special material properties. This wide range of applications is possible through memorization of corresponding key data within the sensor which are automatically taken into account at each measurement

The scope of application is determined by the sensor connected to the gauge**:**

F-type sensors work according to the principle of magnetic induction and can measure non-magnetic coatings such as paint, enamel, rubber, aluminum, chrome, copper, zinc etc applied on iron and steel (including steel alloys and hardened magnetic steels).

N-type sensors work according to the eddy current principle and measure insulating coatings such as paint, anodizing, ceramics etc. applied on all non-ferrous metals (for example aluminum, copper, zinc die cast, brass etc.) including austenitic steels.

FN-type sensors combine both principles and identify the substrate underneath the coating thus automatically switching to the correct measuring principle to measure on base material steel or non-ferrous metal.

Modern data administration allows simple access to the internal data memory with maximum storage capacity of up to 2 million measuring values. MiniTest 4500 features a data memory with ‘APPL-BATCH mode’ allowing measurement and storage of readings in a user definable memory. A total of up to 2,000,000 readings and more than 9,800 batches can be evaluated according to different statistical principles. The option limit setting (LIMIT) offers to determine Cp and Cpk values.

Both models feature a USB interface to connect to notebooks and PCs. MiniTest 4500 additionally offers a Bluetooth interface for wireless data transfer to mobile devices like Smartphones and printers directly on site..

2. First steps

This section addresses first time users of a MiniTest coating thickness gauge introducing the basic functions of the gauge and demonstrating how to take readings.

2.1 Inserting batteries and connecting the sensor

a) Withdraw the gauge and the batteries from the storage case.

b) Untighten the screws of the battery compartment on the back of the gauge using for example a coin and open the battery compartment.

c) Insert the batteries from the supply schedule observing correct polarity (see illustration).

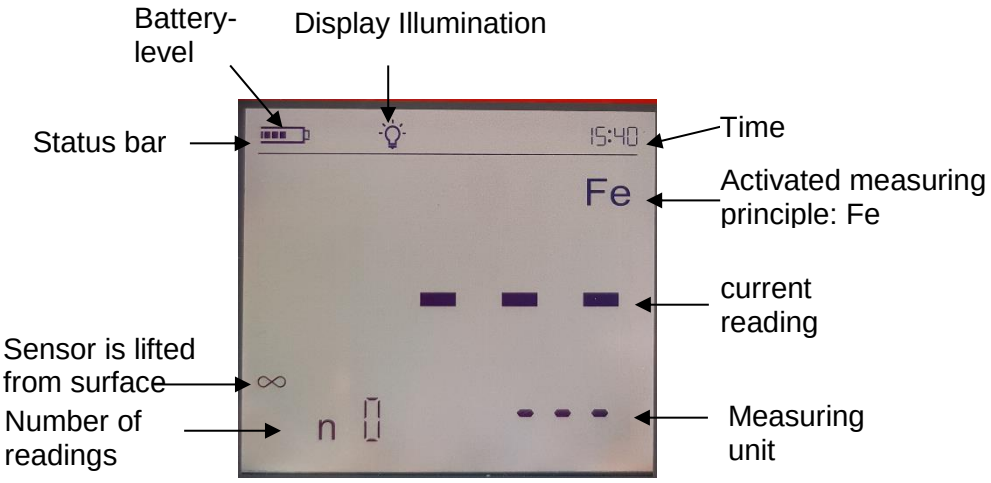
d) Close the battery compartment and fix the lid with the screws.

2.2 Operation of the gauge

Press the red ON-OFF key to switch the gauge on.

a) The gauge is now switched to **measuring mode** (see illustration.) and is ready to measure. The display shows the **measurement screen** without measuring value.

b) Upon initial operation the measuring series is set to „Direct Mode“ and factory calibration is preset (For more detailed information on „Calibration” refer to chapter 6).



c) The factory pre-setting is recommended for quick and easy measurement and if a medium measuring accuracy is sufficient. For a detailed description of different calibration methods refer to chapter 6.2.

d) To take readings, place the sensor in right angle onto the measuring object. The coating thickness will be displayed on the screen after a short while (less than a second). Remove sensor and take next reading.

3. Description of the measuring system

3.1 Gauge

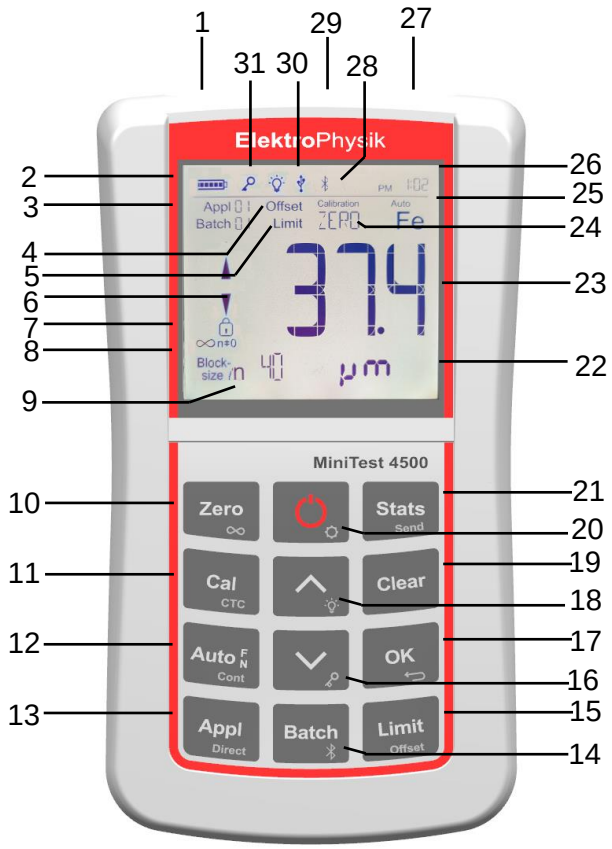
3.1.1 General

A large optionally backlit display allows easy reading of measuring values and statistical data.

The colour of the backlit display is user definable thus offering for example quick marking of a reading within limits in green and outside limits in red.

The housing is made of an impact-proof and scratch-resisting material and conforms to protection class IP 65.

3.1.2 Front view



1. USB-Interface
2. Battery charge level
3. Note: Selected APPL-Batch group
4. Offset note: Offset is activate
5. Limit note: Limits are active
6. Note: Reading is within, above or below preset limits
7. Note: Statistical value (here: Mean value)
8. Note: Readings are blocked
9. Note: Number of readings
10. Zero key to calibrate zero without calibration standard/ Double assignment Recording of infinite value when working with sensor types N10, N20, N100
11. Calibration key for calibration with precision standards / Double assignment Calibration through a coating (CTC)
12. Key to select measuring principle Ferrous, Non-Ferrous or Auto FN when using FN sensors / Double assignment Switch to continuous mode
13. Activation key for DIRECT- or APPL-BATCH Mode
14. Key to access a subgroup (BATCH) within an APPLICATION / Double assignment Activate / Deactivate Bluetooth Interface
15. Key to enter limit values / Double assignment Key to enter an Offsets
16. Arrow keys for navigation in settings, e.g. calibration and limit values, key lock
17. Key to confirm an action / Double assignment ESCAPE or QUIT function
18. Arrow keys for navigation in settings, e.g. calibration and limit values, key lock
19. Delete key
20. ON/OFF switch and initial functions
21. Key to visualize statistical values and transfer measuring and statistical values to printer, PC or APP Miniview
22. Measuring unit: Automatically selected according to preselection of the sensor connected: µm, mm or mils, inches
23. Current reading
24. Active calibration method is displayed; here ZERO
25. Active measuring principle N-Fe (when measuring on non-ferrous metal) or FERROUS (when measuring on steel
26. Display of time
27. Sensor plug
28. Note: Bluetooth active/paired
29. Optional socket: 1. To connect an external trigger (e.g. footswitch), 2. To trigger a signal confirming the measuring value (optical or acoustical), RS 232 Interface
30. Note: PC connection via USB active
31. Note: Keypad locked

3.1.3 Operating keys

MiniTest 2500 and MiniTest 4500 are equipped with a generous keypad. One key pressure is sufficient to access functions like calibration, limit setting, and display of statistics.

The **ON-OFF-key** serves to switch the gauge on or off. Switching the gauge on by simultaneously pressing the ON-OFF key and the keys ∧ + Clear, a total reset is carried out and the gauge returns factory settings (For more detailed information on initial functions refer to section 11.1).

All keys have a double assignment. Simple pressure of a key will access the functions shown in major writing like 'Zero' and 'Stats' (Statistics). Functions shown in minor grey writing like '∞' and 'Send' are accessed by keeping the key depressed for approximately 0.5 seconds.

- '**OK**' confirms settings and selects menu points.
- '  ' quits an action or a menu.
- '∧' or '∨' modify settings and navigate within initial functions.
- '**Clear**' deletes the last reading, the statistics, an application 'Appl', a series of measurements 'Batch' or limit and offset values.
- '  ' opens the table of initial functions
- '  ' activates and deactivates display and keypad illumination
- '  ' locks the keypad with a password
- '  ' activates and deactivates the Bluetooth Interface (only MiniTest 4500).

3.1.3 Interfaces

The model MiniTest 4500 is equipped with a USB and Bluetooth interface. MiniTest 2500 is only equipped with a USB interface.

3.1.4 Power supply

3.1.4.1 Batteries and rechargeable batteries

Coating thickness gauges MiniTest 2500 and 4500 are powered by three alkaline-manganese-batteries 1.5V, type AA / LR6 (included in standard supply); alternatively, the gauge can be operated on rechargeable NiMH batteries type AA / HR6. Please use only the battery types recommended by ElektroPhysik (see section 13.1 Accessories).

When working with rechargeable batteries, the settings of the gauge must be adapted to rechargeable batteries (section 13.1.1). An external charger is required to recharge the batteries (Accessories).

For more detailed information on the use of batteries and rechargeable batteries, refer to section 13.1.1.

Note:

- Remove batteries or rechargeable batteries from the instrument if not in use for extended periods.
- The battery symbol ▭ indicates 5 different battery states. I.
- When reaching the lowest battery state, the battery level symbol will start to flash. In this state, voltage is insufficient for powering the display backlight and keypad illumination. The ☼ symbol is no longer displayed.

- If batteries are completely discharged, the messages „E06“ and „Low Batt“ appear and the gauge switches off.
- Insert fresh batteries within one minute immediately after removing the used ones. If you wait for longer than one minute, time settings may be lost. However, readings and calibration values will remain in memory.
- For field use, replacement batteries should always be at hand
- Erratic readings due to low battery do not occur as the gauge switches off automatically or does not switch on at all if batteries are too low.
- Used or defective batteries or rechargeable batteries may contain hazardous substances and must be disposed of according to the legal provisions of your country.

3.2 Sensors

Select a sensor suitable for your measuring task, plug to the gauge and screw on.

Important: Whenever a sensor is connected or removed, the gauge must be switched off.

All sensor systems (except sensor type CN02 and customized designs) are spring-mounted in the handling sleeve. This construction ensures stable positioning of the sensor with a constant contact pressure. The V-groove at the top of the handling sleeve allows reliable measurement on objects of cylindrical shape.

Hold the sensor at the handling sleeve and place on the object to be measured.

Note: Sensors are equipped with a hard, wear-proof sensor pole. However, sliding sensors across rough and hard surfaces, for example shot blasted surfaces, should be avoided.

3.2.1 Sensors of the MiniTest 1100 – 2100 - 3100 - 4100 series

All sensors of the predecessor series are compatible with coating thickness gauges MiniTest 2500 and MiniTest 4500. However, it is required to perform a one-time adaptation of the sensor to the measurement electronics.

3.2.1.1 Adaptation of sensor types F05, F1.6, F3, F1.6/90, F2/90, F10, F20, N.08 Cr, N02, N1.6, N1.6/90, N2/90, CN02 and FN1.6, FN1.6P, FN 1.6/90, FN2/90

Upon initial connection of the sensor to the gauge, the MiniTest 2500 or 4500 will display “INF” flashing as well as “SET” and “SENSOR IN AIR” when switched on.

Hold the sensor in a sufficient distance to any metal and press the OK key.

‘INF’ and ‘WAIT’ will continue to flash on the display and a counter will count down from 30 to 0.

Keep the sensor away from any metal until the counter has reached ‘0’.

Once the ‘INF’ adaptation is completed, ‘ZERO”, ‘NFe” and ‘ALUMINIUM-PLATE’ will flash on the display when an N-type or FN-type sensor is connected to the gauge.

Place the sensor on the aluminum zero standard.

‘ZERO’ and ‘ALUMINIUM-PLATE’ will continue to flash on the display and a counter will count down from 30 to 0. Do not remove the sensor from the standard until the counter has counted down to ‘0’.

Once the aforesaid adaptation is completed, ‘ZERO”, ‘Fe” and ‘STEEL-PLATE’ will flash on the display when an F-type or FN-type sensor is connected to the.

Place the sensor on the steel zero standard.

‘ZERO’ and ‘STEEL-PLATE’ will continue to flash on the display and a counter will count down from 30 to 0. Do not remove the sensor from the standard until the counter has counted down to ‘0’.

‘SAVE’ and ‘OK’ will flash on the display.

Press ‘OK’ in order to complete the adaptation of the sensor. Gauge and sensor are now ready to measure.

Adaptation of a sensor to the series MiniTest 2500 / 4500 does not affect the use of the same sensor with a gauge from the series MiniTest 1100 / 2100 / 3100 / 4100.

The adaptation procedure can be repeated at any time in point 20 of the initial settings.

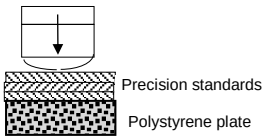
Note: Sensor type F 20 requires a multi-point calibration according to section 7.4 in order to adhere to the tolerances. Sensor type F 50 is only supported by the MiniTest 2500 / 4500 series beginning from software version 1.1.

3.2.1.2 Adaptation of sensor types N10, N20 and N100.

To adapt the sensor to the gauge, the zero standard and the three precision standards from the calibration set supplied with the sensor is required.

When a sensor from the MiniTest 1100-4100 series is connected to a MiniTest 2500 or 4500 for the first time, the gauge will display ‘INF”, ‘SET’ and ‘ON COATING WITHOUT SUBSTRATE‘ after being switched on.

Place the sensor on the three precision standards stacked on top of each other and hold the sensor and the precision standards in the air keeping a sufficient distance to any metal objects or place the three standards on a polystyrene plate. Press the OK key. This procedure eliminates dielectric influences oft he coating material as described in section 7.7.3.



‘INF’ and ‘WAIT’ will continue to flash on the display and a counter will count down from 30 to 0.

Keep the sensor away from any metal until the counter has reached ‘0’.

Once the ‘INF’ adaptation is completed, ‘ZERO”, ‘NFe” and ‘ALUMINIUM-PLATE’ will flash on the display when an N-type or FN-type sensor is connected to the gauge.

Place the sensor on the aluminum zero standard.

‘ZERO’ and ‘ALUMINIUM-PLATE’ will continue to flash on the display and a counter will count down from 30 to 0. Do not remove the sensor from the standard until the counter has counted down to ‘0’.

‘SAVE’ and ‘OK’ will flash on the display.

Press ‘OK’ in order to complete the adaptation of the sensor. Gauge and sensor are now ready to measure.

Adaptation of a sensor to the series MiniTest 2500 / 4500 does not affect the use of the same sensor with a gauge from the series MiniTest 1100 / 2100 / 3100 / 4100.

The adaptation procedure can be repeated at any time in point 20 of the initial settings.

Hold the sensor in a distance to any metal and press ‘OK’.

4. Measuring, Storage and Data Processing in DIRECT or APPL-BATCH mode

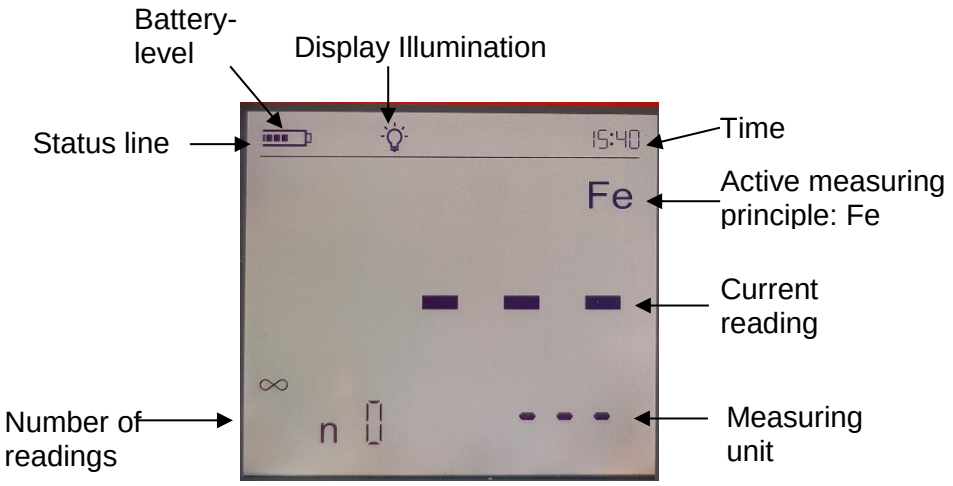
The following section describes:

- the DIRECT mode
- the APPL-BATCH mode
- the structure of APPL-BATCH memory system
- How to change from DIRECTto APPL-BATCH mode
- How to select a scertain memory in APPL-BATCH mode
- How to enter calibration values and limits
- Special features of the APPL-BATCH memory system.

APPL = Application memory
BATCH = Memory for series of measurement

4.1 Switch on / start-up screen

Being switched on the unit will display the **measurement mode** of the last active series of measurements („Batch“).



The model MiniTest 4500 offers two different working modes: ‘DIRECT mode’ and ‘APPL-BATCH mode’.

‘DIRECT mode’ is intended for quick occasional readings. Readings as well as the 6 statistical values (8 if limits have been set) can be shown on the display and printed by pressing STATS’. The statistical analysis function can evaluate up to 9,999 readings.

In ‘APPL-BATCH mode’ a maximum of 10,000 single readings and approx. 500 separate series of measurements can be stored in data memory individually. Single readings, statistical values and the related histogram can be printed directly or at a later point.

Important note:

Working in APPL-BATCH mode (e. g. calibrating, measuring setting of limits etc.) is only possible, when the display shows „APPL BATCH“. Otherwise, activate the APPL-BATCH memory using the keys APPL and BATCH. Also refer to Section 3.4 and 3.5.

Status after Switch on

Press ON key while holding the probe in the air. The gauge automatically resumes the mode selected previously (either ‘DIRECT-’ or ‘APPL-BATCH’).

If start-up proceeds in ‘APPL-BATCH mode’, the gauge will select the ‘APPL-BATCH’ memory previously selected and the last ready (if available) will be displayed.

Calibration values and statistics are stored in memory.

Measurement can start directly in ‘DIRECT mode’ or be continued in ‘APPL-BATCH’ mode provided the gauge works with a valid calibration.

If all data have been deleted, only the measuring unit, e.g. < µm > along with the measuring mode FERROUS or NONFERROUS will be shown depending on the sensor connected to the gauge.

Note:

If you switch from ‘DIRECT’ mode to ‘APPL-BATCH’ mode, all statistical data will be kept in memory.

The statistical data will not be stored if you change the probe.

When pressing the APPL-BATCH key, the pair of numbers of the last active APPL-BATCH memory will be shown on the display.

The gauges switches off automatically according to the selected switch-off-time after the last measurement (see also section 11.1 initial settings).

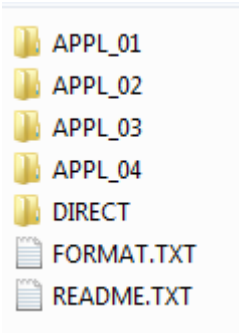
4.2 Structure of the APPL-BATCH system

MiniTest 2500 and MiniTest 4500 generally group reading in series of measurements in one memory batch. MiniTest 2500 features one fixed memory (DIRECT) whereas MiniTest 4500 features one DIRECT memory and 99 application memories (APPL) combined with memories for series of measurements (BATCH).

New readings are always added to the active memory and stored. The gauge will preserve the active memory when switched off and automatically resume this memory when switched on again not requiring any further settings. The following actions are possible:

- Continue to measure in active memory
- Set up a new series of measurement (BATCH) within an application memory (APPL)
- Set up of a new application memory (APPL) with corresponding series of measurement (BATCH)
- Selection of an existing series of measurement (BATCH) within an application memory (APPL)
- Selection of an existing application memory (APPL) with corresponding series of measurement (BATCH))

Perform one of the above mentioned actions in order to specify the active series of measurement (BATCH) for measurements hereinafter.



The application memories (APPL) with their corresponding batch memories (BATCH) allow to store calibration settings for different applications in an application memory (APPL). The batch memory (BATCH) stores single readings of a series of measurement along with their statistical analysis (see illustration: APPL-BATCH memory).

BATCH memory columns								
APPL (application) memory lines		**1**	**2**	**3**	**...**	**97**	**98**	**99**
	1	1	2	3		97	98	99
	2	1	2	3		97	98	
	3	1	2	3		97	98	
	. . .							

	97	1	1	1		97	98	
	98	1	1	1		97	98	
	99	1	1	1		97	98	99

Illustration: APPL-BATCH memory

With **MiniTest 4500** 99 application memories (APPL-memory lines) – subdivided in 99 BATCH-memory columns each, i.e. 9,801 memories in total, are available.

Several million readings can be logged to the memory.

APPL memory line

(for saving calibration values only)

Each of the 99 application memory lines can be allotted a calibration and an OFFSET setting for one probe. A selection of calibrations are thus instantly available for different tasks, e.g. for measuring coating thickness on flat or curved surfaces or for taking measurements using a range of probe types. Once a calibration has been entered into an APPL memory line it remains there and can be activated at any time simply by entering the corresponding APPL number. After this, readings can start immediately within a selected group (BATCH) of particular application memory

BATCH-(Group) Memory

(for storing limits and readings)

Each of the application memories (APPL memory lines) is subdivided into BATCH memories. Each BATCH memory can store a series of readings using one calibration and also evaluate them in statistical form. In addition, a set of two tolerance limits (LO and HI) can be stored in each BATCH memory. The BATCH subdivisions provide for individual assessment of the coatings of a number of product samples measured with one probe and based on the same calibration.

4.3 Switching APPL-BATCH mode on / off

When the gauge is switched on it will resume the previously selected mode, i.e. either APPL-BATCH or DIRECT mode.

In order to switch from DIRECT to APPL-BATCH mode, press ‘APPL’. The last APPL-BATCH number will appear, e.g. < 2 : 1 >.

Either continue taking readings in this APPL-BATCH memory or select a different memory (see section 4.5). Confirm your choice by pressing ‘APPL’ again. Readings can be taken as soon as “APPL-BATCH” appears on display.

To switch from APPL-BATCH mode to DIRECT mode, press and hold the APPL key while the gauge is switched on. DIRECT mode is activated and the gauge is ready to measure.

4.4 Displaying the number of active APPL-BATCH

If the gauge is switched on and is already functioning in APPL-BATCH mode, a reading will normally be displayed.

Press either APPL or BATCH to display the two-number memory in current use, e.g.<2 : 1>. Press the same key again to confirm your choice. Readings can be taken as soon as APPL-BATCH appears on the display.

4.5 Selection of an APPL memory

1. Press the APPL key in order to display the two-number designation of the active APPL-BATCH memory. Use the arrow keys to select a new APPL memory.
2. If you hold down the key you can quickly scroll through the memory showing a running display of numbers already occupied until a free APPL address is found. The number of this memory will then appear on screen, e.g. < 5 : 1>. Free memories can be distinguished by a flashing APPL number.

Note:

An APPL memory can be activated directly by connecting the sensor that served to create the APPL memory originally. If another sensor even of the same sensor type is connected, the message “LOC“ will be displayed along with sensor type and serial number.

This also happens if the probe which has been used for APPL-memory creation has been repaired.

To delete or select APPL-memories please refer to section 9.6

3. The calibration valid for your selected APPLmemory is shown on display, e.g. one-point or twopoint calibration. If the standard calibration is valid, there will be no indication on the display.

   Either maintain the currently valid calibration or recalibrate according to one of the methods described in section 7.1 to 7.13.

4. All following readings will be stored in the selected APPL-BATCH memory.

4.6 Selection of a BATCH memory

1. Select an APPL memory line if this has not been done.
2. Press BATCH. The number of the previously selected number will now appear, e.g. <3 : 2>. If, for example, APPL memory line number 3 has not yet been used, the gauge automatically selects the first BATCH memory, e.g. <3 : 1 >. A free BATCH is indicated by flashing numbers on the display.
3. If required, use the arrow keys to select a new BATCH no. Keep the key pressed down for quickly scrolling through the memory until a free BATCH number is found. The number will then be displayed, e.g. <3 : 8>. Press BATCH to confirm.

5. Measuring

5.1 Important Notes on Coating Thickness measurement

Make sure the operator has been properly instructed regarding the use of coating thickness gauges and has basic knowledge of the specific requirements for measurement of the application. The operator should have basic knowledge of the following:

- Appropriate selection of a measuring device suitable for his application
- Fundamentals on the electro-magnetic measuring principle
- Influences through magnetic fields and the surrounding fields
- Influence through the surface properties of the object to be tested (roughness, shape and build-ups on the surface)
- Statistical evaluation of measuring series

5.1.1 Interpretation of readings

The information obtained from the coating thickness measurement only refers to those parts of the test object that have been covered by the sensor. For that reason, conclusions may not be drawn on parts of the measuring object that have not been covered by the sensor during measurement. In general, such conclusions are only admissible if comprehensive experience and approved methods of statistical data acquisition are available.

5.2 Basic settings

Before taking readings, it is necessary to adjust a few settings:

Fix the data format for data storage before the first use of the gauge.

Either comma or point are available. This setting is important for later transfer of data to a spreadsheet calculation for example Microsoft Excel (see section 10.2)

If required or necessary, the following settings can also be performed at initial set-up:

- Definition of block statistics (see section 8.3)
- Limit setting (see section 8.4)
- Offset setting (see section 8.2)

All readings will be stored to the active APPL-BATCH memory.

Note:

Limits can still be set after readings have been taken.

5.3 Preparing measurement

5.3.1 Calibration

According to your setting of task, you may use different calibration methods. Measuring accuracy depends on the selected calibration method. .

The following calibration methods are available. (see section 6.2):

- Factory presetting
- Zero point calibration
- Two-point calibration
- Multi-point calibration
- Calibration through a coating when the base material is not accessible (CTC)

5.4 Taking readings

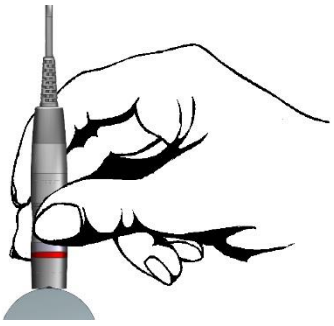
5.4.1 Taking readings without using the sensor stand

All sensor systems are spring-mounted to ensure a safe contact pressure on the measuring object without tilting. The V-groove of the sensor ensures correct positioning of the sensor on cylindrical objects.

To take readings, place the external sensor onto the object to be measured. As soon as the sensor has been placed onto the object, a reading will be displayed and will be registered for statistics when working in “single value” mode. Lift the sensor briefly from the surface and take the next reading.

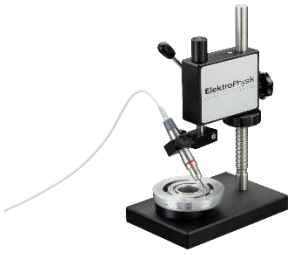
In „continuous mode”, readings are displayed continuously as long as the sensor scans the surface. To store the single reading being displayed into the statistics, press the „OK” key.

Note that grinding movements on the measuring object will affect the sensor pole (small pin in the center of the sensor end surface touching the measuring object) and lead to abrasion which should be prevented in order to maintain the high precision of the gauge.



5.4.2 High-precision stand

In order to take readings on small objects and small geometries, it is recommended to use the external sensor in connection with the high-precision stand.



Measurement with standard sensor

5.4.3 Duplex coating systems

To add additional corrosion protection to a product or for design reasons, it is common practice to apply a zinc coating to a steel product before painting. For measurement of zinced steel with additional surface finish, please use the dual sensor FN 1.6. This sensor type allows to determine the total coating thickness working in „Ferrous" mode and then the thickness of the paint coating on the zinc substrate working in „Non-Ferrous"mode. The thickness of the zinc coating is calculated by subtracting the paint thickness from the total thickness value.

Verify the zero value in non-ferrous setting with a zinc-coated but not yet painted sample. Starting from a 50µm zinc thickness, the zero value is sufficiently good so that you can measure your duplex coating as described aboven.

5.5 Errors during measurement

After the sensor has been calibrated, you can proceed on taking readings in the measuring mode. Readings will be correct as long as the sensor specifications will be observed. Please refer also to section 6.1 Calibration "General remarks" and Section 13 "Technical specifications".

5.6 Measurement on high temperatures using high-temp sensors

The measuring system MiniTest 2500 / MiniTest 4500 (gauge + sensor) is designed for a maximum operating temperature of 50°C / 122°F for the gauge and 70°C / 158°F, at short periods 120 °C / 248°F for the sensor. Whilst the current operating temperature of the gauge depends on the ambient temperature of the air, the current operating temperature of the sensor is also influenced by the surface temperature of the object to be measured. This is due to the heat transfer taking place when the sensors comes into contact with the object to be measured.

Measurements on objects with surface temperatures higher than the specified sensor operating temperature are permissible with the special high-temperature sensors

80-0A1-1202 - F2 HT up to 250°C / 482°F and
80-0A1-1302 - F2 HT up to 350°C / 662°F

under the following conditions.

1. When taking readings, a measuring signal will sound approx. 1 second after placing the sensor onto the object to be measured in order to confirm acquisition of the reading. Make sure to lift the sensor immediately after the bleep sounds. This is to keep the heat transfer from the object to the sensor as low as possible. Do not keep the senor in contact with the measuring object for longer than one second.
2. Note that between two subsequent measurements on hot surfaces, a recovery time is required to cool down the sensor. Please refer to the table below for the temperature

depending recovery times. If the below recovery times are respected, a virtually unlimited number of subsequent measurements can be taken.

3. During a measurement pause, make sure not to place the sensor on hot surfaces to prevent heating up. Keep the sensor away from hot measuring objects to prevent heating up through heat radiation.

Sensor recovery times in high-temp operation						
Temperature / °C	100	150	200	250	300	350
Temperature / °F	212	302	392	482	572	662
Recovery time / s	1	2.5	6	12	20	30

6. Calibration

6.1 General notes on calibration

The MiniTest 2500/4500 series offers a number of calibration methods to meet the individual requirements of various applications, procedures and industrial standards.. When a batch is being created you can select a suitable calibration method for this batch. The calibration can be carried out immediately after you have created a batch or at a later time in measuring mode using the „CAL" key. The calibration method can be changed as long as no readings are stored in the currently active batch.

A calibration is made in the currently active batch and is directly related to this batch.

To ensure an optimum calibration, the following points should be observed:

- Correct calibration is vital for accurate measurement. For calibration, a sample similar to the later object to be measured should be used, i.e. both, calibration sample and the object to be measured should be of the same shape and geometry. As a rule, you can say that the more similar the calibration sample and the later object to be measured are, the more accurate calibration and thus accuracy of readings will be.
- Make sure the calibration sample and the later object to be measured have same characteristics such as:
  - identical curvature radius of surface
  - identical substrate materials (such as magnetic permeability, electrical
  - conductivity; in the ideal case, they should be made of the same material)
  - identical substrate thickness
  - identical size of measuring area
- Before starting calibration, make sure the calibration spot, the sensor tip and the calibration standard are clean. If necessary, remove any built-ups such as grease, metal chips, etc. Any impurities might affect calibration and lead to erratic calibration.
- Make sure the calibration position and the measuring position are always the same, this applies especially for measurement on small parts and measurements at edges and corners.
- Keep away from strong magnetic fields during the calibration procedure.
- For maximum accuracy of calibration and later measurements, choose the thickness of calibration standard within the same thickness range as the later measuring sample.
- For measuring thick non-ferrous metal coatings on steel or ferrous substrates according to the magnetic induction method (using sensor type F 1.6, FN 1.6, F3, F10 or F20) a multi-point calibration must be carried out. The thickness standards must be of the same metal as the later object to be measured.
- If using calibration foils, make sure they are placed in plane position on the substrate material. Any air gap below the foils must be avoided as this would lead to erratic readings. If the foils are curved, make sure to place on them on the substrate as shown below (see illustration).

- The precision thickness standards must be handled with care. Any wear-and tear of the thickness standard will be reflected as erratic calibration value. Do not fold calibration foils.

Any buckling will cause air gaps below the foil and result in erratic readings. Keep thickness standard clean, free from grease, oil, dust or other build-ups. Build-ups on the foils will be considered as thickness and will lead to a measuring error of the same value as thickness of build-up. To give you a rough idea: a build-up from a finger-print will be enough to add an additional thickness of some microns.

Please note:

If the gauge switches off during the calibration procedure due to low battery, the calibration procedure must be repeated after batteries inserting fresh batteries .

6.2 Calibration methods

According to your setting of task, you may use different calibration methods. Measuring accuracy depends on the selected calibration method. For more details see sensor-specifications, section 14.2.

6.2.1 Factory pre-setting

The status line shows: **„„„**.
The factory pre-setting is used for quick and easy measurement with a medium accuracy (for more details please refer to section 14.2 Sensor Specifications). This calibration mode setting will be valid as long as you do not choose and/or activate another calibration mode.

6.2.2.1 Zero Calibration

The status line shows: **„ZERO „**.

Calibration point: zero point (directly on the substrate material).

Calibration is to be made on an uncoated calibration sample of the same geometry and material as the later measuring object. Only one calibration point is to be taken directly on the substrate to give you the zero point
Zero calibration - is for quick calibration if a medium accuracy is sufficient.

6.2.2.2 Two-point Calibration

The status line shows: **”Z 1 „**.

Calibration points: zero point (directly on the substrate material) and on the precision standard.

Calibration is to be made on an uncoated calibration sample of the same geometry and material as the later measuring object. Two calibration points are to be taken: one directly on the substrate to give you the zero point, the other one on a precision standard which is put on the substrate.

Compared to the zero calibration, this calibration method implies a higher accuracy. Accuracy will increase if the thickness of the precision standard is close to the thickness of the later object to be measured.

6.2.2.3 Multi-point Calibration

The status line shows: **„Z 1“ „Z 2“ „Z 3“ „Z 3“**

Calibration points: zero point (directly on the substrate material) and on two to four precision standards.

Calibration is to be made on an uncoated calibration sample of the same geometry and material as the later measuring object. Three calibration points are to be taken: one directly on the substrate to give you the zero point, and two further ones on two precision standards to be put on the substrate.

It is recommended to choose a precision standard to cover the lower half of expected thickness range, the other one should be in the higher half of expected thickness range.

This calibration method should be used if readings are to be taken over an extended thickness range and if a high accuracy is required.

6.2.2.4 Two-point Calibration without zero

The status line shows: **“12“**.

Calibration points: two precision standards) (no zero point).

Calibration is to be made on an uncoated calibration sample of the same geometry and material as the later measuring object. Two calibration points are to be taken on two precision standards which are to be put on the substrate. The first precision standard should be thinner than the thickness to be expected, the other one should be thicker than the thickness to be expected. There is no zero point to be taken directly on the uncoated sample. There is no zero point to be taken directly on the uncoated sample.

This specific calibration method should be used when taking readings on rough surfaces. Taking zero point on rough surfaces would imply strong deviations due to the uneven surface. That’s why zero point is omitted in this calibration method as this would lead to erratic calibration and thus affect accuracy.

6.2.2.5 Calibration through a coating (CTC)

The status line shows: “CTC“.

Calibration using a calibration foil. Recommended if the test sample is coated and no uncoated sample is available for comparison. This method is suitable for the following probes. F05, F1.6, F1.6/90, F3 and FN1.6 (only F-part), F1.6/90, F10, F20 and F50.

6.4.3.1 Calibration of FN-type sensors

Calibration can be performed in direct mode or in an active batch for the F-part as well as for the N-part of the system.

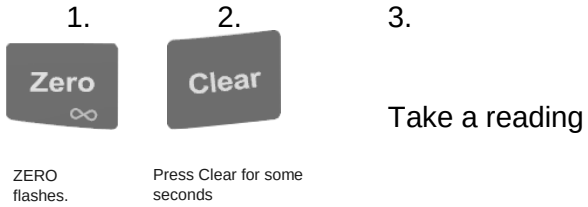
If “Auto FN“ is activated, pressing of the “Zero” or the “Cal” key will display the message “Substrate”. Select Fe or NFe using the keys „ “or „ “ and confirm with the “OK” key. .

If no selection is made at all, the gauge will automatically display FERROUS after about 5 secs. And select the magnetic induction method.

7. Calibration

7.1 Activate factory settings

Applies to all sensor types (except CN02).

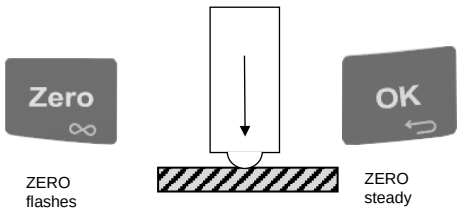


Calibration using a calibration foil. Recommended if the test sample is coated and no uncoated sample is available for comparison. This method is suitable for the following probes.

Note:

Verify on an uncoated sample if zero is read with sufficient accuracy. In case zero is not read correctly, perform a zero or two-point calibration.

7.2 Zero Calibration



Applies to all sensors (except CN02 and continuous mode).

1. Press ZERO to initialise ZERO calibration. The display will show ‘Calibration ZERO’ (flashing).
2. Place the probe on uncoated sample (zero coating thickness) and raise it after the bleep. Repeat this procedure several times. The display always shows the mean value of the previous readings.
3. Press ZERO to complete Zero calibration. ‘ZERO’ is displayed steadily.
4. Now take readings by placing the probe on the object to be measured and raise the probe after the bleep. The reading is shown on display.

Deleting a zero calibration: (for example necessary if an incorrect zero value has been entered.):

a) Press ZERO and then CLEAR for a longer time to delete the zero calibration and any existing CAL calibration.

Note:

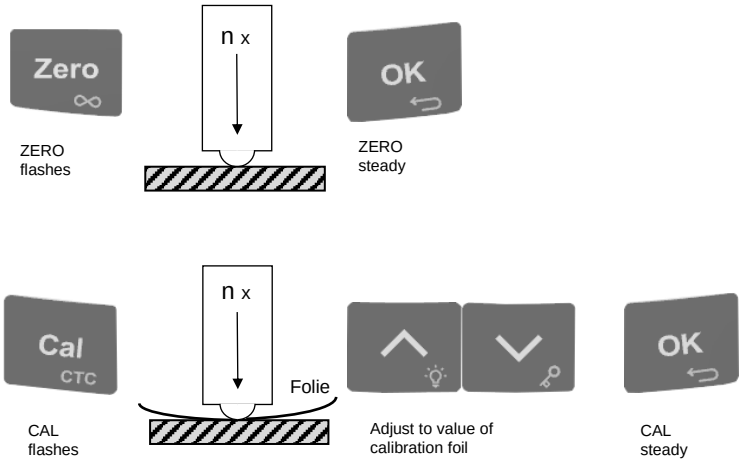
This will reactivate the default standard calibration for use on even surfaces.

b) or restart ZERO calibration by repeating steps 1 to 3 above. This automatically deletes the old calibration and saves the new one.

Note:

ZERO calibration deletes any existing CAL calibration.

7.3 Two-point calibration (zero setting plus one calibration foil)



Applies to all sensors (except CN02 and continuous mode).

This method is recommended for high precision measurements, measurements on small parts and on hardened and low-alloy.

1. Press ZERO to initialize ZERO calibration. ‘ZERO’ flashes
2. Place the probe on uncoated sample (zero coating thickness) and raise it after the bleep. Repeat this procedure several times. The display always shows the mean value of the previous readings.
3. Press the OK key to complete zero calibration. ‘ZERO’ is displayed steadily.
4. Press CAL to initialize foil calibration. ‘CAL’ flashes
5. Place the calibration foil on an uncoated sample, apply the probe and raise it after the bleep. The thickness of the foil should be roughly equivalent to the estimated coating thickness. Apply the probe to the test sample several times. The display always shows the mean value of the previous readings. To discontinue calibration, press CLEAR.
6. Adjust to the thickness of the calibration foil using the ARROW keys.
7. Press the OK key to complete CAL calibration. ‘CAL’ is displayed steadily.
8. Now take readings by placing the probe on the coating and raise it after the bleep.

It may be necessary to delete CAL calibration, e.g. after entry of a faulty calibration value:

a) Press CAL key followed by CLEAR key. CAL calibration is now deleted.
ZERO calibration is now activated.

b) Restart CAL calibration by repeating steps 4 to 7 above.

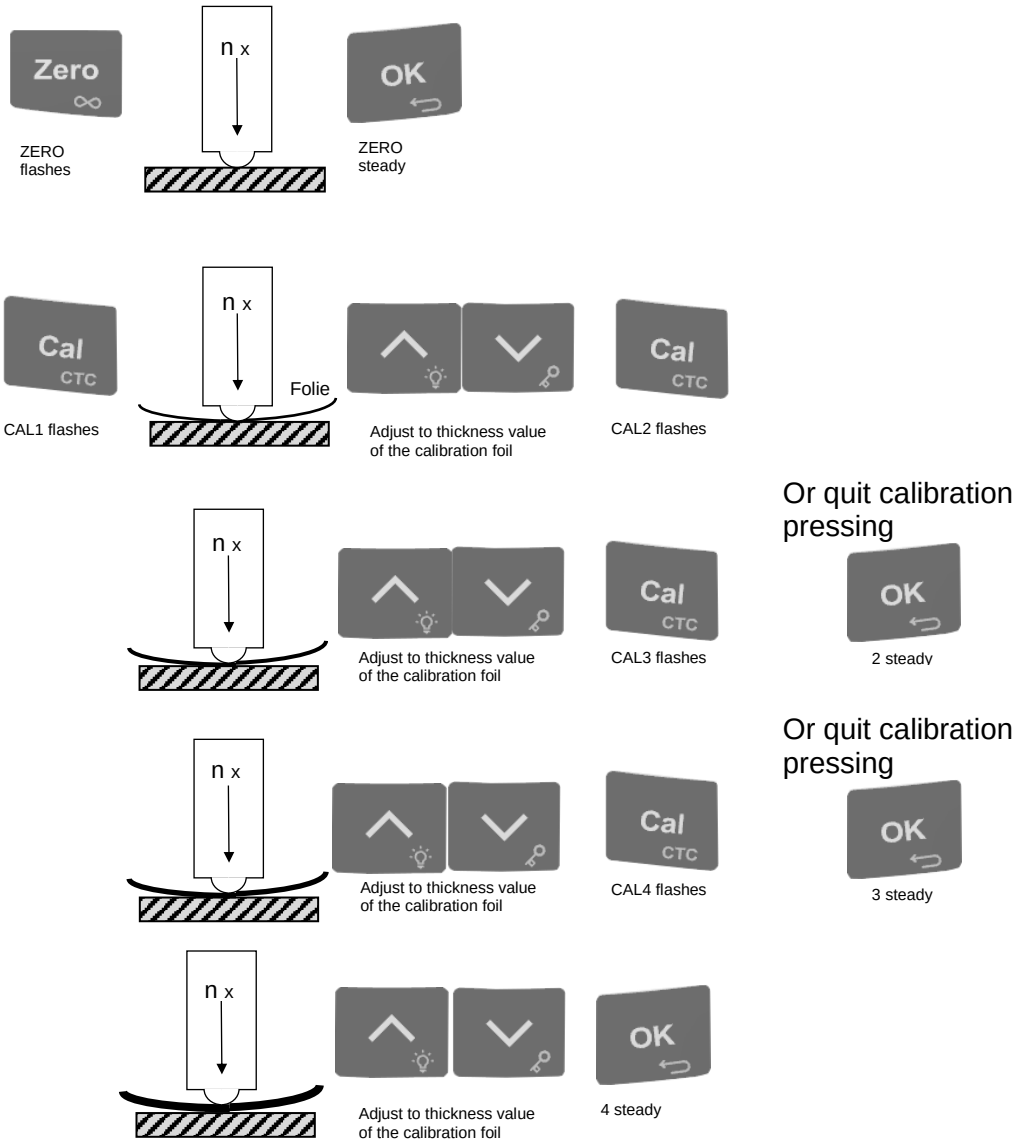
Note:

Even while a series of measurements is being taken, foil calibration can be carried out as often as necessary. The old calibration will be overwritten; the ZERO calibration remains in memory.

Special remark

When using F10, F20 or F50 probes for measuring on metal coatings, it is essential to carry out two-point calibration. The calibration standards must be of the same metal as the actual coating. Under certain circumstances, this may also apply to F probes with a low measuring range.

7.3 Multi-point calibration (zero setting plus up to four calibration foils)



Applies to all sensors (except CN02).

This calibration method is recommended for high precision measurement and measurements taken over a larger scale of coating thickness values.

1. Press ZERO to initialise ZERO calibration. ‘ZERO’ flashes
2. Place the probe on uncoated sample (zero coating thickness) and raise it after the bleep. Repeat this procedure several times. The display always shows the mean value of the previous readings.
3. Press the OK key to complete zero calibration. ‘ZERO’ is displayed steadily..
4. Press CAL to initialize foil calibration. ‘CAL’ flashes.
5. Place the calibration foil on an uncoated sample, apply the probe and raise it after the bleep. The thickness of the foil should be roughly equivalent to the estimated coating thickness. Apply the probe to the test sample several times. The display always shows the mean value of the previous readings. To discontinue calibration, press CLEAR.

6. Adjust to the thickness of the calibration foil using the ARROW keys.
7. Press the Cal key in order to initialize the following calibration point. ‘CAL2’ flashes.
8. Repeat steps 5 and 6.
9. Press the Cal key in order to initialize the following calibration point. ‘CAL3’ flashes. If the OK key is pressed instead of the CAL key, the calibration procedure will be completed with at the previous point. ‘Z 2’ is displayed.
10. Repeat steps 5 and 6.
11. Press the Cal key in order to initialize the following calibration point. ‘CAL4’ flashes. If the OK key is pressed instead of the CAL key, the calibration procedure will be completed with at the previous point. ‘Z 3’ is displayed.
12. Repeat steps 5 and 6.
13. Press the OK key in order to confirm that calibration is completed, ‘Z 4’ is displayed.
14. Now position the sensor on the coating to be measured and lift after the bleep.

It may be necessary to delete CAL calibration, e.g. after entry of a faulty calibration value:

c) Press CAL key followed by CLEAR key for some seconds. CAL calibration is now deleted. ZERO calibration is now activated.

d) Restart CAL calibration by repeating steps 4 to 13 above.

Note:

Even while a series of measurements is being taken, foil calibration can be carried out as often as necessary. The old calibration will be overwritten; the ZERO calibration remains in memory.

Note:

Measurement of metallic coatings using sensor types F10, F20 or F50 requires a two-point calibration. This may also apply to F type probes for smaller measuring ranges. Calibration standards must be made of the same metal as the coating to be measured.

7.5 Two-point calibration using two calibration foils without zero calibration

Applicable to all sensors (except CN02)

Calibration is only possible in single measurement mode. If necessary switch to the mode as in section 4.1. This method requires the use of two different foils. The thicker one should be, if possible, twice as thick as the thin one. According to probe, the following foils should be used:

F05, F1.6, FN 1.6, N02, N1.6 (as of production date 26.08.04):	min. 10µm
F10, N10:	min. 100µm
F20, N20:	min. 400µm
F50:	min. 1000µm (1mm)
N100:	min. 5000µm (5mm)
All other sensors:	min. 25µm

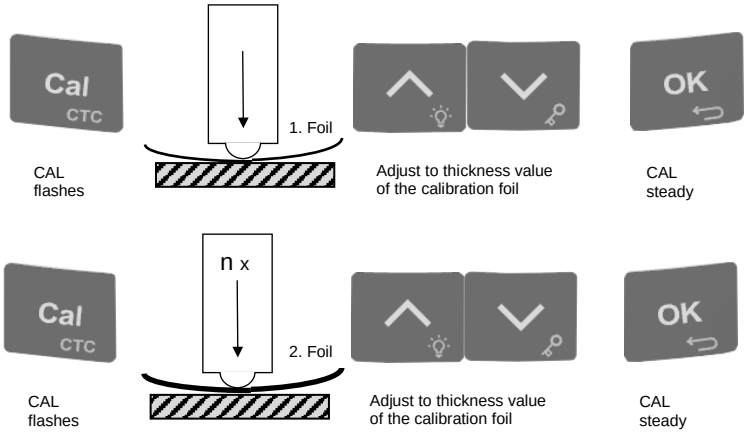
For best results, the thickness to be expected should be somewhere between the two calibration values.

This method is especially suitable for taking measurements on rough shot-blasted surfaces or for high-precision readings. It is advisable to take a mean of CAL values. This considerably reduces the effect of scattering which occurs during calibration of upper and lower values.

Note:

Before carrying out the two-foil calibration, the factory set standard calibration should be enabled (see also 4.2.1).

Press ZERO key followed by ”Clear“ and “OK“. Proceed with step 1.



The calibration foils may be used in any order.

1. Press the CAL key to initialize the calibration procedure. ‘CAL I’ flashes.
2. Place the thinner of the two foils (e.g. approx. 30µm) on the uncoated test sample, apply the probe and raise it after the bleep. Repeat this procedure several times. The display will show the mean value of readings taken previously.
3. To discontinue calibration at any time, press CLEAR. All calibration values entered so far will be deleted and the calibration procedure can be continued taking new readings. In order to discontinue and quit the calibration procedure, press “OK/⇦“ for several seconds.
4. If necessary, adjust the value displayed to the thickness value of the calibration foil using the arrow keys.
5. Press the CAL key in order to calibration with the second foil. ‘CAL2’ flashes on the display.
6. Place the thicker of the two foils (this should be at least twice as thick as the other foil) on the uncoated sample, apply the probe and raise it after the bleep.

   To discontinue calibration at any time, press CLEAR. All calibration values entered so far will be deleted and the calibration procedure can be continued taking new readings. In order to discontinue and quit the calibration procedure, press “OK/⇦“ for several seconds.
7. If necessary, adjust the value displayed to the thickness value of the calibration foil using the arrow keys.
8. Press OK, Calibration ‘2’ is displayed steadily.
9. Now take readings placing the sensor on the coating to be measured, lift after the bleep and read the measuring value on the display.

It may be necessary to delete CAL calibration, e.g. after entry of a faulty calibration value:

a) Press CAL and CLEAR key followed by OK key. The second calibration value is now deleted.

b) Pressing the CLEAR key for a longer time will delete both calibration values.

Note:

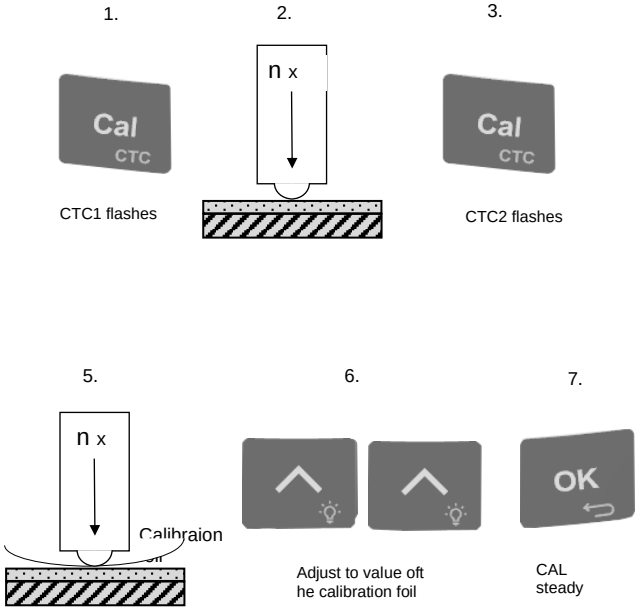
The default standard calibration for flat surfaces is now active.

c) For a new CAL calibration repeat steps 2 -7. The previous calibration is deleted and the new calibration is active.

7.6. Calibration Through the Coating

(**C**AL-**T**HROUGH-**C**OATING: **CTC**: Procedure according license patent DE3404720C2)

This method is recommended when an uncoated test sample is not available. It can be employed with the probe types F06, F1.6, F3, FN1.6 and FN2 (F-part), F1.6/ 90, F2/90, F10, F20 and F50. The CTC method may, however, only be used when the coating is smooth at the calibration point and measured values are reproducible. Do **not** use for textured coatings.



1. Press CAL/CTC key for some seconds to initialize CTC calibration. CTC1 flashes.
2. Place the probe on the calibration point of the test sample and raise it after the bleep. Repeat this procedure several times. The display always shows the mean value of the previous readings.
3. Press CAL key.
4. Place the calibration foil on the same point, apply the probe and raise it after the bleep.The thickness of the foil should be roughly equivalent to the estimated coating thickness. Apply the probe to the test sample several times. The display always shows the mean value of the previous readings.
   To discontinue calibration, press CLEAR.
   All calibration values entered so far will be deleted and the calibration procedure can be continued taking new readings. In order to discontinue and quit the calibration procedure, press „OK/⮌“ for several seconds.
1. If necessary, adjust the value displayed to the thickness value of the calibration foil using the arrow keys.
2. Press OK key shortly to confirm and complete CTC calibration. ‘CTC1’ is displayed steadily.

3. Now take readings placing the sensor on the coating to be measured, lift after the bleep and read the measuring value on the display.

It may be necessary to delete CAL calibration, e.g. after entry of a faulty calibration value:

a) Press CAL for several seconds and then CLEAR key for several seconds. CTC calibration value is now deleted.

Note:

The default standard calibration for flat surfaces is now active.

a) For a new CTC calibration repeat steps 2 -7. The previous calibration is deleted and the new calibration is active.

7.7. Sensors N10 and N20

Switch on gauge. The gauge automatically switches to „Continuous Mode“. This mode will be of advantage when measuring with the N10 and N20 probes. The “Continuous Mode“ will be indicated by 3 strokes flashing (- - -) in the area of the measuring unit (µm, mm, cm). Readings beyond the measuring range will be indicated by 3 steady strokes (**- - -**).

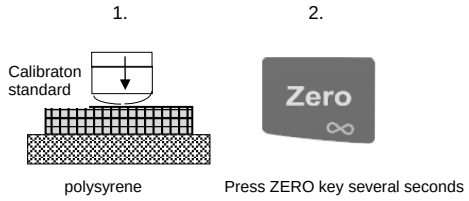
After the gauge has been switched on, the display will show “INF“ and “Sensor in Air“. Hold the sensor away from any kind of metal and press the key ZERO/∞ key for several seconds.

To switch to “Single measurement mode“ press “Auto FN/ Cont“ for several seconds.

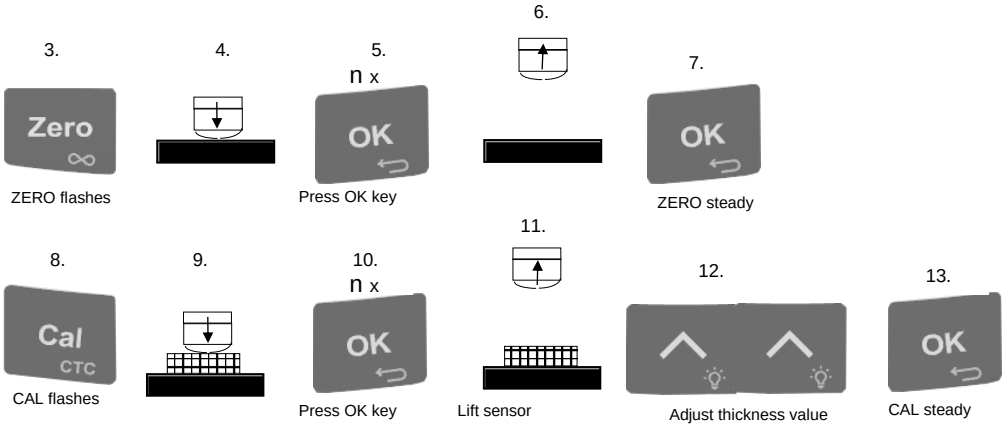
During calibration with N10 and N20 probes the dielectric properties of the calibration standard and of the coating material must be taken into consideration

7.7.1 Standardization (Acquisition of Infinite Value)

Place the probe on the thicker of the two supplied standards, without any metal underneath. To avoid any external dielectric influences, an effective base for the standard is a polystyrene block of at least 3cm thickness and press ZERO/∞ key for several seconds.

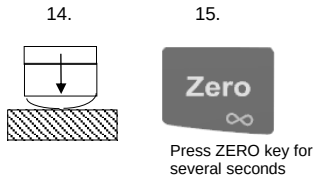


7.7.2 Two-point calibration (zero setting plus one calibration foil)



7.7.3 Elimination of dielectric interferences of the coating material

Place the sensor on the coated sample avoiding any kind of metal support! Press ZERO/∞ key for several seconds.



Note:

The automatic compensation of temperature related interferences is now disabled. In case of changes in working temperature, repeat the calibration if necessary.

7.8 N100 Sensor

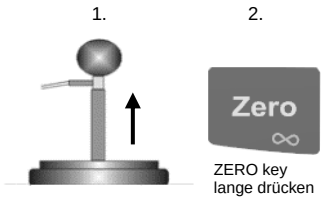
For coating or wall thickness measurement with the N100 probe, the base material can be of ferrous or non-ferrous metal.

The base must be a minimum 300x300 mm. With smaller areas, the measuring tolerance will be greater. For minimum error the following is recommended:

1. For calibration choose a spacer whose thickness is similar to the expected coating or wall thickness, respectively (see following calibration principle).
2. Make a two point calibration (7.3) with two spacers. Here the expected thickness should lie between that of the two spacers.
3. Switch the gauge on. The gauge automatically switches to “Continuous Mode“. This mode will be of advantage when measuring with this probe. The “Continuous Mode“ will be indicated by 3 strokes flashing (- - -) in the area of the measuring unit (µm, mm, cm). Readings beyond the measuring range will be indicated by 3 steady strokes (- - -).
4. After the gauge has been switched on, the display will show “INF“ and “Sensor in Air“. Hold the sensor away from any kind of metal and press the key ZERO/∞ key for several seconds.
5. To switch to “Single measurement mode“ press „Auto FN/ Cont“ 

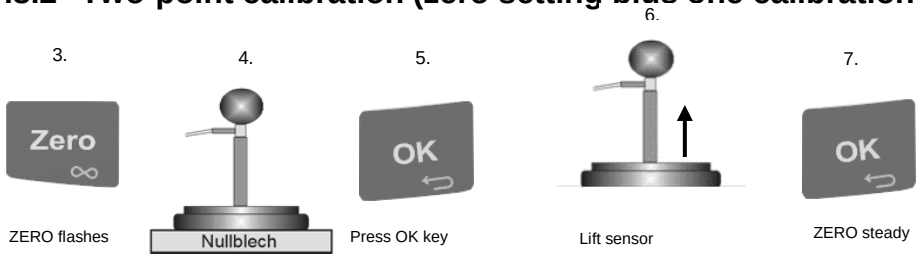
for several seconds.

7.8.1 Standardization (Acquisition of Infinite Value)



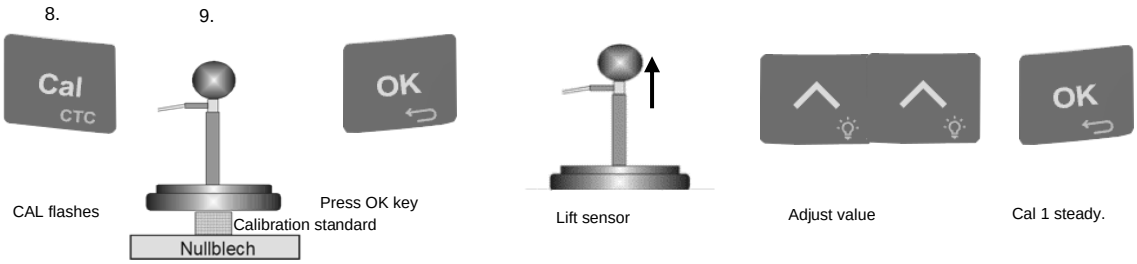
Hold the sensor in the air and press ZERO/∞ key for several seconds.

7.8.2 Two-point calibration (zero setting plus one calibration foil)



Zero calibration

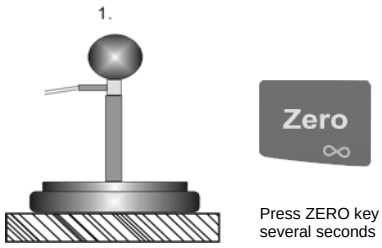
Press the ZERO key and place the sensor on the zero standard. Press the OK key shortly several time, the mean value of readings is calculated. Lift the sensor and press OK key shortly.



Press CAL key. CAL flashes.

Place the spacer supplied - e.g. 50 mm - in the recess in the base of the probe. The thickness of the spacer should be similar to that of the expected thickness to be measured. Place the sensor along with the spacer on the zero plate (measuring reflector) holding the sensor bottom plate in a parallel line to the reflector. Press the OK key several times shortly to calculate the mean value. Adjust to the spacer thickness with arrow keys and confirm pressing OK.
CAL calibration is completed, CAL is displayed steadily.

7.8.3 Elimination of dielectric interferences of the coating material



Place the sensor on the coating material (min. 30 mm) avoiding any metal support!

Press ZERO/∞ key several seconds.

The elimination of dielectric interferences must be carried out for both calibration procedures 6.2.2.2 and also 6.2.2.3. The gauge is now ready to measure.

Note:

It is recommended that you check and repeat the calibration occasionally, e.g. after using the gauge for more than two hours or in case of variations of temperature of more than 10°C. If the gauge is to be used on other types of material, point 7.8.3 must be repeated.

7.9 Sensor F20

Switch on gauge. The gauge automatically switches to “Continuous Mode“. This mode will be of advantage when measuring with the F20 probes. The “Continuous Mode“ will be indicated by 3 strokes flashing (- - -) in the area of the measuring unit (µm, mm, cm). Readings beyond the measuring range will be indicated by 3 steady strokes (**- - -**).
After the gauge has been switched on, the display will show “INF“ and „Sensor in Air“. Hold the sensor away from any kind of metal and press the key ZERO/∞ key for several seconds.

To switch to “Single measurement mode“ press „Auto FN/ Cont“ Auto FN Cont for several seconds.

Also refer to section 6.1 ‘General Notes on Calibration’.

Place the sensor on the coating to be measured. If required, transfer the reading to the statistics witih the OK **key**.

Note:

For older F20 sensors to ensure the assured accuracy (14.2 sensor specifications) perform a multi-point calibration according to 7.4.

Working with display illumination in continuous mode will increase power consumption.

7.10 Sensor F50

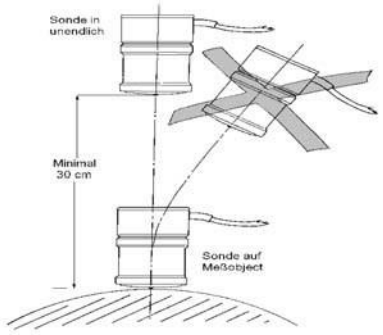
Switch on gauge. The gauge automatically switches to “Continuous Mode“. This mode will be of advantage when measuring with the F50 probes. The “Continuous Mode“ will be indicated by 3 strokes flashing (- - -) in the area of the measuring unit (µm, mm, cm). Readings beyond the measuring range will be indicated by 3 steady strokes (**- - -**).

After the gauge has been switched on, the display will show “INF“ and “Sensor in Air“. Hold the sensor away from any kind of metal and press the key ZERO/∞ key for several seconds in order to compensate temperature effects and drift.

To switch to “Single measurement mode“ press „Auto FN/ Cont“ Auto FN Cont for several seconds.

Notes on calibration and measurement using F50 probe:
Use the calibration and measurement routines of this instruction manual. In addition, the following remarks should be observed:

The position of the probe influences the measuring result. The infinite value automatically taken by the instrument or probe must be taken from the same angle to the measuring object as the reading which is to be taken later on. Further, the probe must be moved at a constant speed towards the measuring object.



In order to avoid hysteresis errors, after each measurement, the probe must be held away from the measuring object ensuring a minimum distance of 0.3m / 12“ away from any metal parts.

Note:

The magnetic field created by the measuring probe might interfere with or even destroy electronic or medical equipment or gauges in the vicinity. To avoid such interference, it is recommended to keep a distance of at least 1m / 40“ away from such instruments or any magnetic data carrier

7.11 Tube sensors F1.6/90, F2/90, N1.6/90 and N2/90

In single measurement mode, proceed as normal for calibration and measurement. In continuous measurement mode, the use of tube probes requires a slightly different procedure:

Calibration should be carried out in single measurement mode according to 7.2-7.4. For F1.6/90 and F2/90 sensors, proceeding according to section 7.5 is also possible.

Working in continuous mode, the last reading displayed can be transferred to the statistics memory either by pressing the OK key or triggering the footswitch (optional).

Select the measuring mode ‘Single mode’ or ‘Continuous mode’ pressing the key  for several seconds.

7.12 Chrome Coatings on Copper

Applicable to sensor type N08Cr using a special calibration foil

1. The two-point calibration according to section 7.3 must be used.
2. Only use the special calibration foil for chrome on copper.

7.13 Sensor CN02

The CN02 is a flat probe for use on even surfaces. Only one-point calibration using one calibration foil is required.

1. To measure the thickness of copper laminates or copper foil:
2. Press the CAL key to initialize calibration. ‘CAL’ flashes.
3. Place the metalic calibration foil on an insulating piece of minimum 10mm thickness, apply the probe and raise it after the bleep.The thickness of the foil should be roughly equivalent to the estimated sample thickness. Apply the sensor to the metallic calibration foil several times. The display always shows the mean value calculated from the previous readings.
4. If necessary, adjust the value displayed to the thickness value of the calibration foil using the arrow keys.
5. Press CAL key, ‘CAL’ is displayed steadily.
6. Now position the sensor on the coating to be measured and lift after the bleep..

Note:

Measurements on double-sided laminated PC boards will require calibration using a double sided laminated copper standard.

7.14 Recalibration in an APPL memory line

Also refer to diagram 3.1 Structure of the APPL-BATCH system.

If recalibration is carried out for an APPL memory line, all stored values and statistical data are retained. The new values will simply be added to the old ones. It is up to the operator to decide if two different calibrations are permissible for one series of measurements.

This method can be used to store a series of measurements in various BATCH groups of any one APPL memory line in succession, even if these have different calibrations.

Note:

Only the last recalibration will become valid. Any previous calibration within the same APPL-memory line will become invalid.

7.15 Shot-blasted and rough surfaces

7.15.1 General

To remove rust in order to ensure a good adhesion of the paint, surfaces are commonly blasted in pre-treatment. As a result, the base material gets rough. Roughness influences the measuring results, i.e. readings will be higher than the actual thickness.

The following section describes some steps how to remove the influence of roughness in coating thickness measurement.

For calibration and for determining the average, it is generally recommended to take at least a set of 10 readings.

If you proceed on thickness measurement according to the steps below, the average thickness over the peaks will be displayed. Note that the statistics program is of great benefit in this procedure.

7.15.2 Method A (roughness Rz > 20µm)

Carry out a two point-calibration according to section 7.3 use a smooth (non blasted) and clean calibration sample with the same geometry and the same substrate as the later measuring sample.

Now take approx. 10 readings on the uncoated, shot-blasted sample to produce the mean value $\bar{x}_0$.

After this take approx. 10 further readings on the coated, shot blasted test sample to produce the mean value $\bar{x}_\mathrm{m}$.

The difference between the two mean values is the mean coating thickness $\bar{x}_{eff}$ over the peaks. The greater standard deviation σ of the two values $\bar{x}_\mathrm{m}$ and $\bar{x}_0$ should also be taken into consideration: $\bar{x}_{eff} = (\bar{x}_\mathrm{m} - \bar{x}_0) \pm \sigma$

7.15.3 Method B (roughness Rz < 20µm)

- Carry out a zero calibration of 10 readings on a shot-blasted, uncoated sample. Then carry out a foil calibration on the uncoated substrate. The foil set should consist of a number of individual foils of max. 50 microns thickness each and should roughly correspond to the estimated coating thickness.
- The coating thickness can be read directly from display and should be averaged from 5...10 single measurements. The statistics function is useful in this context.

7.15.3 Method C Calibration with two calibration foils of different thickness

- This method also gives reliable results. Simply follow the two-point calibration method using two foils as described in section without zero setting.
- For a maximum approach to the respective nature of surface, the foil value can be reached by using several foils - 50µm each.The mean coating thickness should be calculated from 5...10 readings. The statistics programme is very useful in this context.

Note:

For coatings thicker than 300 µm, the influence of roughness generally is of no importance and it will not be necessary to apply above calibration methods.

8. Data Management

8.1 Batches

8.1.1 General

MiniTest 4500 offers unique possibilities of data administration.

The MiniTest 4500 gauges store measuring values, calibration, statistics and parameters as an associated data set in batches, i.e. to each batch a calibration, parameters and a statistic related to the batch are assigned along the measuring values. If an existing batch is called up, calibration and parameters assigned to this batch are activated.

The gauges have a total memory capacity of approx. 2 million measuring values. These values can be assigned to 99 application memories with 99 sub memories, i.e. batches, each. Working with application memories is useful when varying measuring tasks requiring different calibrations or sensors have to be met in regular intervals. The application memory registers the calibration once performed as well as the sensor connected to the gauge. Once MiniTest 4500 is adjusted to the different measuring tasks, carrying out a sequence of measurements is extremely easy and quick. Permanent recalibration can be omitted and measurement errors are nearly excluded.

Measuring sequences can be evaluated according to different statistical principles allowing a significant evaluation of each sequence.

Setting limits facilitates to monitor during measurement process if the workpiece still adheres to allowable tolerance.

Provided limits were set, an acoustic signal is triggered each time a thickness value outside these

8.2 Offset

The offset function allow automatic addition or subtraction of a constant value to / from the reading so that deviations from a target value can be quickly identified and documented. (not available with the calibration method „”actory presetting“).

8.3 Block size

Subsequent readings of a batch can be divided into blocks, each of the same size (block group of readings). The number of readings per block can be adjusted from 1 to 99. A statistics will be created for each block.

For a statistcs from single readings (statistics including all readings in a series of measurements), the block size must be set to 1.

8.4 Upper limit / Lower limit

Upper and lower limits can be set to monitor deviations from the set point. Readings out of the predefined limit range will be signaled optically through the red LED above the keyboard as well as acoustically; furthermore, these readings are tagged in the list of single readings.

Limits can be set at any time, i.e. before, during and after taking a series of readings.

8.5 Single values / Continuous measurement mode

The continuous measurement mode is suitable for some special applications (for example measurement with an internal tube sensor) allowing to measure without lifting the sensor between readings. Set the gauge to work in continuous mode as follows.

1. Switch the gauge on.
2. Press and hold 

. A short bleep confirms that the continuous mode is active.
3. 'Continuous mode' is signalled through three flashing lines instead of the measurement unit (µm, mm, cm). Readings without the measuring range of the sensor connected will also be displayed with three lines (**- - -**).
4. Readings are logged to the statistics memory either by pressing the OK key or actuating the optional footswitch.
5. Return to single measurement mode by repeating point 2.

8.6 Measuring with statistics

For MiniTest 4500, two different statistical programs are available: single value statistics and block value statistics (DIN 50982).

Within the APPL-BATCH memory system (siehe Section 3) calculates statistics from a maximum of 100 series of readings while MiniTest 4100 is able to calculate statistics from as much as 500 measuring series. In total, a maximum of 10,000 single values can be stored.

Single value statistics

All readings of a measuring series are automatically stored for statistical evaluation. From each measuring series, the following statistical values are calculated or printed out:

Readings:	:	Number of single readings
Mean:	:	Mean value of single readings
SdtDev:	:	Standard deviation
Var	:	Variation coefficient
Maximum	:	Maximum reading
Minimum	:	Minimum reading
cp	:	process capability index
cpk	:	process capability index

Block value statistics

Block value statistics are only available in APPL-BATCH mode. In DIRECT mode, only the single value statistics can be calculated.

In this mode, the readings of a series are logged in blocks.. The size of a block is alterable via the initial settings.

The statistics are calculated from the mean value (x) of a block. The analysis of any series appears on the display and on the print-out as follows:

N-Groups : Number of blocks or groups

MEAN ($\bar{x}$) : Mean of mean values

ST.D (s) : Standard deviation (Mean value)

KVAR : Variation coefficient (Mean value)

MAX : Max. mean value of all blocks

MIN : Min. mean value of all blocks

Every fifth measurement is confirmed with a long beep.

Statistics are being calculated from a minimum of 2 single values or 2 blocks offering six or 8 (including cp and cpk) provided limits have been set.

8.7 Taking a series of measurement with statistical calculation

Working in DIRECT mode (Press and hold Appl/Direct key):

1. Switch on gauge and take readings. All readings will be automatically logged to the statistics program.
2. Remember to check whether calibration is required and/or if any redundant statististical values need to be deleted. To recalibrate, simply overwrite the existing calibration.

To delete an existing calibration, proceed as follows.

Press the key “Stats“ and then “Clear“.

3. To continue a series of measurements in DIRECT mode after the gauge had been switched off, simply switch the gauge on again and continue to take readings.

Working in APPL-BATCH mode:

IF necessary, press APPL key to activate the APPL-BATCH mode. The number of the previously activated APPL-BATCH memory is displayed. If necessary, select another APPL-BATCH memory (see Section 3.4).

1. To delete a measuring series including its statistics, press FUNC and CLEAR/STATS key.
2. If necessary, enter new calibration values and tolerance limits (see section 5.3.1, 6 and 7). All readings will be automatically logged to the statistics program.
3. To continue a series of measurement in an APPL-BATCH memory after the gauge had been switched off, simply switch the gauge on again and continue your series of measurements.

8.8 Deleting outliers or erratic readings

Deletion must take place immediately after an outlier orerratic reading has been taken (see also section 9). Press Clear key once.

8.9 Storage capacity overflow

In the unlikely event that the memory capacity is exceeded (~ 100,000,000 readings) the error message E22 "FILE ERROR" appears. Delete unneeded Appl-Batch memories.

8.10 Display or print-out of a series of measurements

The MiniTest 4500 features a USB- and a Bluetooth interface, Minitest 2500 only a USB interface. All measuring and statistical values logged to the memory can be:

- printed on a data printer MinPrint 7000 BT via the Bluetooth interface,
- transferred to a PC software for example MSoft 7000 via USB cable or wireless Bluetooth,
- read out using a PC connection.

8.10.1 Single value statistics

In 'Single Value Statistics' mode, statistical values can be printed or displayed as follows.

1. Displaying statistics

   Each time the STATS key is pressed the statistical values will appear in the following: n (number of readings), x (Mean), σ (SdtDev.), v (Var), ▲ (Maximum), ▼ (Minimum), Cp, Cpk.

2. Visualize single readings

Display the statistical menu by pressing the key "Stats" during measurements.

The arrow keys "^" or "v" allow to scroll through the single readings of a series of measurements. The gauge will display a sequential number of readings n1, n2.. the active measuring principle Fe or NFe and the corresponding measuring value.

3. Complete print-out of measuring and statistical values

Press and hold Stats/Send key. If the gauge is connected to a printer MiniPrint 7000 BT via Bluetooth (only MiniTest 4500), all measuring values including statistics, date, time and sensor type in use will be printed now.

Alternatively, these values can be transferred to a PC terminal program, for example MSoft 7000 via the USB interface.

Press Stats/Send key and hold.

```
Gauge  type:   MT4500
Gauge  serial: 000003
Sensor type:   FN1.6
Sensor serial: 51708

Appl:          04
Batch:         03
Create date:
     12/06/18 08:46:04
Change date:
     12/06/18 08:47:33

Number of
readings:  12
Mean:      485,8 um
SdtDev:    3,1 um
Var:       0.644 %
Maximum:   490,5 um
Minimum:   481,5 um
Cp:        2.663
Cpk:       1.518
HiLimit:   500 um
LoLimit:   450,0 um
```

```
 1 Fe  484,5 um 12/06/18 08:47:19
 2 Fe  483,0 um 12/06/18 08:47:20
 3 Fe  490,5 um 12/06/18 08:47:22
 4 Fe  490,5 um 12/06/18 08:47:23
 5 Fe  485,0 um 12/06/18 08:47:24
 6 Fe  481,5 um 12/06/18 08:47:25
 7 Fe  483,5 um 12/06/18 08:47:26
 8 Fe  483,0 um 12/06/18 08:47:27
 9 Fe  485,0 um 12/06/18 08:47:29
10 Fe  490,0 um 12/06/18 08:47:30
11 Fe  487,5 um 12/06/18 08:47:31
12 Fe  485,0 um 12/06/18 08:47:33
```

Note:

To cancel printing, press and hold OK

Statistical values can be viewed at any time, even while a series of measurements is being taken.

8.10.2 Block value statistics

In block value statistics mode (see section 11.2.1), statistics can be displayed or printed out as below.

1. Displaying single value statistics

   Each time the STATS key is pressed the statistical values will appear in the following: n (number of blocks), $\bar{\bar{x}}$ (Mean of all blocks), σ (StdDev), V (Var), ▲ (Maximum block value), ▼ (Minimum block value), Cp, Cpk.

2. Visualize block values

Press “STATS” key to enter the statistic menu.

The arrow keys “^” or “v” allow to scroll through the single readings of a series of measurements. The gauge will display a sequential number of blocks 1, 2…, the active measuring principle Fe or NFe and the corresponding block value ($\bar{x}$) and as well as alternately the standard deviation (σ) of the block.

3. Complete print-out of measuring and statistical values

Press and hold Stats/Send key. If the gauge is connected to a printer MiniPrint 7000 BT via Bluetooth (only MiniTest 4500), all measuring values including statistics, date, time and sensor type in use will be printed now.

Alternatively, these values can be transferred to a PC terminal program, for example MSoft 7000 via the USB interface.

Press Stats/Send key and hold.

Note:

To cancel printing, press and hold OK

Statistical values can be viewed at any time, even while a series of measurements is being taken.

```
Gauge  type:   MT4500
Gauge  serial: 000003
Sensor type:   FN1.6
Sensor serial: 51708

Appl:          04
Batch:         03
Create date:
     12/06/18 08:46:04
Change date:
     12/06/18 08:59:07

Number of
blocks:    3
Blocksize: 5
Mean:      485,9 um
SdtDev:    1,2 um
Var:       0.239 %
Maximum:   486,7 um
Minimum:   484,6 um
Cp:        7.176
Cpk:       4.038
HiLimit:   500 um
LoLimit:   450,0 um


   1 Fe  486,7 um (3,5 um) 12/06/18 08:47:24
   2 Fe  484,6 um (3,3 um) 12/06/18 08:47:30
   3 Fe  486,5 um (2,0 um) 12/06/18 08:59:05
```

9. Deletion

9.1 Deleting the last reading

Shortly press the clear key immediately after the measurement. The indication of number of readings n is reduced by one.

9.2 Deleting statistical values

Enter the statistics menu by pressing “Stats“ and then press and hold „Clear“.

A short acoustic signal confirms deletion.

Calibration values are maintained.

9.4 Deleting a series of measurements including limits and statistics within an APPL-BATCH memory

Example APPL-BATCH Gruppe <03:02>.

Calibration values are not deleted.

1. Press the BATCH key and select a BATCH no. using the arrow keys. (see Section 4.6.)
2. Press CLEAR key and hold. A short bleep confirms deletion. “Batch xx“ flashes and indicates that the APPL-BATCH group is vacant.

ATTENTION !

All measuring values and settings of this series of measurements are irrevocably deleted and there is no possibility to restore deleted data.

9.5 Deleting limit values within an APPL-BATCH memory

Exampe APPL-BATCH memory <2:3>.

1. Press BATCH drücken and use arrow keys to select a BATCH number (see section 3.5) and confirm with BATCH. LIMIT is displayed.
2. Press LIMIT key; LIMIT flashes.
3. Press CLEAR key and hold. “Limit “ is no longer displayed and a short bleep confirms deletion.

9.6 Deleting all series of measurements incl. statistics, limits and calibration values of an APPL memory

Example in memory 2:1; 2:2; 2:3, ...2:99

1. Press APPL and use arrow keys to select an APPL no. (see section 3.4). For example <2:5> is displayed.
2. Press CLEAR and hold. An acoustic signal confirms deletion. An APPL no. flashing indicates a free application memory.

9.7 Total Reset

A Total Reset deletes all measuring series including readings, calibration, limits and statistical values in all APPL-BATCH memories.

1. Switch off gauge.
2. Press Clear, ^ and ON one after the other and hold. “NO“ and „TOTAL RESET“ flashes red on the display. Use the v key to opt “Yes“ and confirm with OK. An acoustic signal confirms deletion.

10. Data output and transfer

The MiniTest 4500 features a USB- and a Bluetooth interface, Minitest 2500 only a USB interface.

All measuring and statistical values logged to the memory can be
- printed on a data printer MiniPrint 7000 BT via the Bluetooth interface,
- transferred to a PC terminal program MSoft7000 via USB cable or wireless Bluetooth,
- send to the APP Miniview for Android Smartphones or Tablets.

The USB interface of the MiniTest 2500 and MiniTest 4500 offers to transfer all memorized measuring and statistical values of a measuring series to a PC (terminal program, for example MSoft 7000). The output format corresponds to the format of the print-out with MiniPrint 7000 BT.

10.1 Printing data

Transfer of measuring and statistical values to values to a data printer MiniPrint 7000 is done via the wireless Bluetooth interface. Prior to printing, the printer must be paired to the MiniTest 4500.

An active Bluetooth interface is confirmed by the symbol  on the display.

Press and hold

Press and hold the ON/OFF key to enter the initial settings. Use arrow keys to scroll to function 17 and press OK to pair the gauge with the printer. Once the printing function is activated, the display shows the message “Bt printer“. If the printing function is inactive, the error message „E 18“ and „BT- DEVICE NOT FOUND” is displayed. Data transmission is indicated by  and the display message “Send printer“.

If the error message “BT- DEVICE NOT FOUND” is displayed, check the Bluetooth configuration of the printer. If the error message “BT CONNECTION FAIL” is displayed, check the battery level, the paper and the configuration of the printer.

10.2 Data transfer to PC (terminal program)

All measuring and statistical values logged to the memory can be printed on a data printer MiniPrint 7000 BT via the Bluetooth interface or transferred to a PC terminal program MSoft7000 via USB cable or wireless Bluetooth.

The Bluetooth interface of the PC (operating system Windows) must be paired with the MiniTest to allow data transfer and MSoft 7000 program must be set to interface Bluetooth.

An active Bluetooth interface is confirmed by the symbol  on the display.

Press and hold 

After activation of the printing function, the message SEND“ and „BLUETOOTH“ or „USB“ is displayed. If no connection to a PC exists or can be set up, the Message „Bt Printer“ and after a few seconds the error message „E 18“ and „BT- DEVICE NOT FOUND” is displayed“. Data transmission is indicated by the display message “Send printer“.

If the error message „BT- DEVICE NOT FOUND” is displayed, check the configuration of the PC / Software.

Note:

After activation of the printing function, the message “SEND“ and “Bluetooth” is displayed. If no connection to a printer / PC exists or can be set up, the error message “E18“, “BT-

DEVICE NOT FOUND” is displayed, check the configuration of the PC and the software (MSOFT 7000).

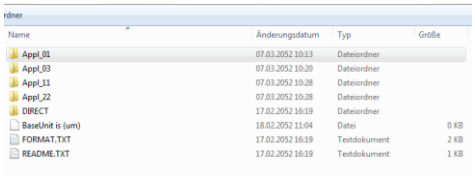
10.3 Read out data via a PC

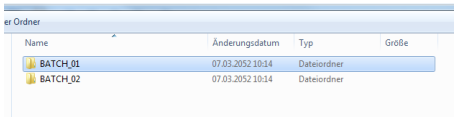
Connected to a PC, the MiniTest gauge acts like a USB bulk memory, e.g. USB memory sick. Recorded measuring values are filed in the directories “Direct” when using MiniTest 2500 and referring to the corresponding application and batch memory as CSV file (BATCH_01.csv) when using MIniTest 4500. The data format **CSV** implies *Comma-separated values* and describes the structure of a text file for storage or exchange of data with a simple structure. This data format can be read by common spreadsheet programs as for example Microsoft Excel, Numbers (for Mac OS X) or Calc (OpenOffice).

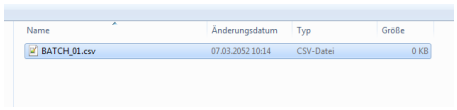
Spreadsheet applications allow to clearly list individual statistical values, process, present and re-memorize them.

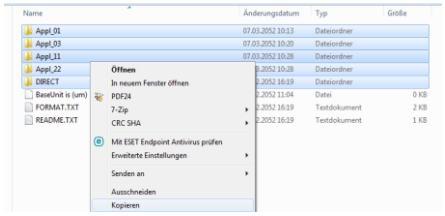
Connect the MiniTest via USB cable to a PC and press. 

The display message “USB Storage“ signals that the MiniTest is connected to the PC as USB bulk memory. Saved measuring series can now be copied to the PC using the Explorer function for further data processing.









.

11. Further functions

11.1 Initialization

Initial functions and settings

Some functions of the MiniTest 2500/4500 can only be entered / activated during switch on.

Table of initial functions

Function	Key sequence
Total-Reset	∧ + Clear + ON
LCD-Test	∧ + ON

11.1.1 Total Reset

A total reset deletes all statistical values, limits and calibration values of all APPL-BATCH memories. The initial functions are reset to factory presettings. (see table in section 11.2.24 und 11.2.25).

1. Connect a sensor to the gauge.
2. Switch the gauge off.
3. Press Clear, ∧ and the ON/OFF key one after the other and hold. “NO“ and “TOTAL RESET“ flash in red on the display. Select “YES” using the ∨-key and confirm with OK. An acoustic signal confirms the total reset and the gauge returns to measuring mode.

11.1.2 LCD Segment Test

This test allows to show and check all segments of the LC display.

1. MiniTest ausgeschalten.
2. -Press ∧ and hold, then press ON/OFF key. All available segments are displayed. Press OK key to quit the test and return to measuring mode.

11.2 Gauge configuration

Various parameters of the gauge can either be set before the first use or or when necessary.

Press ⏻-and hold. A sequence of parameters can now be accessed ⚙.

Use the arrow keys “∧“ or “∨“ to select the required parameter and access by pressing the OK key.

Select the appropriate setting within this parameter using the arrow keys “∧“ or “∨“ and confirm with OK.

Use the key “⇦“ to quit an action and return to measuring mode.

11.2.1 Blockgröße

“BLOCKSIZE” possible setting **1**, 2 … 99 measuring values

Successive single values of a measuring series can be condensed to blocks of same size (Blocking or measuring values.). The number of single readings per block is user definable from 1 to 99. A block statistic is created from each block.

In order to produce a single value statistic (including all measuring values of the measuring series) set the block size to 1.

11.2.2 Display illumination

The parameter “Backlight“ allows to adjust the illumination of the display.

The following settings are available for display illumination 20%, 40%, 60%, 80%, 100%

Display illumination can be easily activated or deactivated pressing the “💡“ key. If the illumination is deactivated, it will nevertheless shortly light up (approx. 1 second) each time a reading is taken. Working with activated display illumination increases the power consumption thus reducing the battery lifetime. In case of low battery level, the gauge will automatically switch to lowest illumation setting.

11.2.3 Keypad illumination

MiniTest 2500 and MiniTest 4500 feature a backlit keypad.

Working with the setting “Auto” in parameter “KEYBOARD LIGHT“, the keypad will be backlit for 4 seconds each time a key is actuated or a reading is taken. Settings “ON” and “OFF” permanently activate or deactivate the keypad illumination.

Working with activated keypad illumination increases the power consumption thus reducing the battery lifetime. In case of low battery level, the gauge will automatically switch off the keypad illumation.

11.2.4 Acoustic signal

The parameter “SOUND“ activates or deactivates the acoustic signal confirming each measuring value and key actuation with the settings “ON” and “OFF”.

11.2.5 Time and date stamp

The parameter “CLOCK” offers to select between time format **24h** or AM/PM.

11.2.6 Time and date

The setting “TIME/DATE” allows to visualize and set the time and date.

MiniTest 2500 and MiniTest 4500 feature a quarz-controlled watch for time and date. The current time is displayed in the right part of the status line in the display. This clock also serves to log the dated and time of settings and of the last change in a batch (Batch). If the timestamp function is activated (see section 11.2.9) the time and date of each reading will be memorized alongside the measuring value.

In order to visualize or set time and date proceed as follows:

1. HOUR flashes and the current hour, e.g. <10>. Adjust using the arrow keys and confirm with OK.
2. MINUTE flashes and the current minute, e.g. <16>. Adjust using the arrow keys and confirm with OK.
3. YEAR’ flashes and the current hour, e.g. <2018>. Adjust using the arrow keys and confirm with OK.
4. .

5. MONTH flashes and the current hour, e.g. <05>. Adjust using the arrow keys and confirm with OK.

6. DAY flashes and the current hour, e.g <14>. Adjust using the arrow keys and confirm with OK.

Note:

The clock stops to run once this parameter is opened. If time and date shall only be visualized without changes, press"⇦" repeatedly to return to measuring mode.

11.2.7 Measuring unit: 'metrical' - Inch' (imperial)

The parameter "Unit" defines the measuring unit system: „metricalh" (Units „"µm", "mm", "cm"), or "imperial" (units "mils", "inch").

Set to "AUTO µm" and „AUTO mils" the gauge will select an appropriate measuring unit depending of the factor of the coating thickness value displayed and will display this value in floating point notation. Set to "FIX µm", "FIX mm" and "FIX cm" or "FIX mils" and "FIX inch" the coating thickness value will be displayed with a fixed decimal point according to the measuring unit.

Note:
The settings of the measuring unit also define the data format during measurement and direct data output see 11.2.18 „DATA OUTPUT".
Note that when working with sensors F10, F20, F50, N10, N20 and N100 the setting "FIX µm" will not supply any values greater than 9999 µm to display, memory and statistics.

11.2.8 Automatic data transfer in continuous mode

The continuous mode allows to log measuring values manually or automatically to the memory and hence also to statistics or direct output via an interface (see section 11.2.18):

Set the data transfer in continuous mode to automatic transfer in parameter "AUTO LOGGING".

If the parameter is set to "OFF", data is only transferred manually either by pressing the "OK" key or actuating the footswitch (optional accessory).

The settings "1/SEC", "2/SEC", "5/SEC", "10/SEC" and "20/SEC" activate and define the transfer rate to the statistics and data memory to a transfer of 1, 2, 5, 10 or 20 readings per second. The automatic transfer will be triggered during measurement by pressing the "OK" key and is terminated by pressing the "OK" key again. In case a footswitch (optional) is connected, the transfer of measuring values is active as long as the footswitch is actuated.

It is recommended to start the automatic data transfer after the sensor is positioned on the measuring object and stopped before the sensor is lifted from its position. This avoids the transfer of misleading measuring values resulting from positioning and lifting the sensor to the statistics. Select a low transfer rate for slow movements and a high rate for quick scan movements.

11.2.9 Timestamp

The parameter "TIMESTAMP" activates (ON) or deactivates (OFF) the time and date stamp for recording of a measuring value. If set to ON each measuring value will be logged to the batch along with time and date.

For example. 18 Fe 0.7 at 15/05/18 10:36:38

11.2.10 Setting of display colours for measurements

The parameter "COLOR READING" sets the colour of the display illumination for display of measurement values: NONE deactivates the display illumination, 1 (red), 2 (green), 3 (yellow), 4 (blue), 5 (magenta), **6 (cyan)**, 7 (white).

11.2.11 Setting of display colours for readings above preset limits

The parameter “COLOR HI-LIMIT“sets the colour of the display illumination to signal that a limit has been exceeded: NONE deactivates the display illumination, 1 (red), 2 (green), 3 (yellow), **4 (blue)**, 5 (magenta), 6 (cyan), 7 (white).

11.2.12 Setting of display colours for readings below preset limits

The parameter „COLOR LO-LIMIT“ sets the colour of the display illumination to signal that a limit has been exceeded: NONE deactivates the display illumination, **1 (red)**, 2 (green), 3 (yellow), 4 (blue), 5 (magenta), 6 (cyan), 7 (white).

11.2.13 Optional alarm output – Setting of signal length of the measuring value

The parameter “ALARM READING-TIME” sets the signal length of a measuring value within limits.

The optional alarmoutput offers the possibility to connect a visual or audible alarm unit or a control unit to the gauge. In order to distinguish between a measuring value within limits and exceeding values of the upper or the lower limit, the length of the alarm signal can be set separately. Setting options are:: OFF, 50ms, 100ms, 150ms, 200ms, 250ms, 300ms, 350ms, 400ms or continuous).

11.2.14 Optional alarm output – Setting of signal length for readings above limits

The parameter “ALARM HI-LIMIT“ sets the signal length for a measuring value exceeding the upper preset limit, see section 11.2.13

11.2.15 Optional alarm output – Setting of signal length for readings below limits

The parameter “ALARM LO-LIMIT“sets the signal length for a measuring value exceeding the lower preset limit, see section 11.2.13

11.2.16 Configuration of the optional foot switch

In continuous mode, measuring values are only logged to the memory when either the OK key is pressed or an external switch contact (foot switch) is actuated.

The parameter “FOOTSWITCH MODE“ offers the following settings for the optional foot:

Setting = “**SAVE**“ -> the reading on the display will be logged to the statistics when the footswitch is actuated.

Setting =”**DELETE**“ -> when working in single value mode, the last reading taken will be deleted when the foot switch is actuated.

11.2.17 Pairing of a BLUETOOTH printer

To set up a Bluetooth connection between data printer MiniPrint 7000 BT and MiniTest 4500, it is necessary to pair the devices once.

Select the parameter “BLUETOOTH PRINTER” using the “⩓“ or “⩔“ key and access setting with OK.

The display shows “WAIT“ while an active Bluetooth printer is searched for. If no active Bluetooth printer is found, “NO DEVICE FOUND“ is displayed.

When an active Bluetooth printer is found, the display shows **I** : I flashing and a moving font shows the Bluetooth MAC address e.g.: „00802545F6BD“ of the printer. Confirm the Bluetooth printer by pressing the OK key.

If several active Bluetooth printers are found, the display will show “SET“ flashing and **I** : 2 (when two printers are available) as well as the Bluetooth MAC adress of the first printer found. Use the arrow keys “⩓“ or “⩔“ to switch between the two printers found **I** : 2 and **2** : 2. The Bluetooth MAC

address of the corresponding printer is shown as moving font. Select one of the printers and confirm with OK key.

11.2.18 Configuration of DATA OUTPUT interface for direct data output

The direct outpout of measuring values to an interface is standardwise deactivated (“OFF“).

If measuring values shall be directly transferred to the interface during measurements, the parameter “DATA OUTPUT“ offers to select oe of the interfaces ”USB“, “RS232“ (optional), “BT-PRINTER“ “Bluetooth Drucker“ or “BT-PC“ Bluetooth–PC.

This setting provides DIRECT transfer of measuring values to a documenting or processing system for example a Bluetooth data printer as well as a software for quality control or production control.

Note: See also section 11.2.7 „UNIT“ measuring unit ‘metrical - Inch (imperial) for settings of the measuring unit as well as the settings for data structure of the file „Format.txt“ in the root directory of the MiniTest 2500 / MiniTest 4500.

11.2.19 Format of logged measuring values

The parameter “DATA STORAGE” defines the data format of the measuring values looged to the memory.

NOTE: This parameter can only be set before a first reading had been taken, i.e. after delivery or after a total reset.

In factory setting, measuring values are stored in µm using a point as decimal separator:
10.2 ;Fe ;06/06/18;14:46:39
484.5 ;Fe ;06/06/18;14:46:42

The decimal separator is important for data transfer to a spreadsheet program as for example Microsoft® Excel® or a quality control software.

The following settings are offered:

Measuring unit	**Decimal separator**	**Setting**
µm	Komma	“COMMA µm“
µm	Point	“**DOT µm“**
mils	Komma	“COMMA mils“
mils	Point	“DOT mils“
Datenspeicherung deaktiviert		“OFF“.

11.2.20 SENSOR INIT

For adaption of sensors from the MiniTest 1100… MiniTest 4100 gauge family refer to section 3.2.1

11.2.21 „POWER SUPPLY“ Setting

The parameter “ POWER SUPPLY” sets the power supply to batteries or rechargeable nickel metal hydride batteries (NiMH).

The parameter”Power supply“ defines the type of batteries used in order to display the correct scale of the battery level. This setting is required as batteries and rechargeable batteries operate on a different voltage level.

Select the appropriate power supply using the arrow keys “ ” or “ ” and confirm the setting with the OK key. If the setting does not correspond to the batteries inserted, the battery level indicator and the automatic switch off in case of low voltage do not function correctly.

11.2.22 „POWER OFF“ Switch off time

The gauge features an energy saving mode to switch off the unit after a user definable period of inactivity.

Select the parameter “POWER OFF” using the arrow keys “ ” or “ ”and open the settings with the OK key.

Adjust the switch off interval using the arrow keys “ ” or „ “ and confirm the setting by pressing the OK key. The following options are available: 1, 3, 10, 30 minutes or permanent operation “ (no automatic switch off).

11.2.23 SYSINFO

This parameter serves to visualize identification data of the unit Please inform this data to your service contact in case of after-sales service.

GTYP = gauge type, GSER = gauge serial number, STYP = sensor type, SSER = sensor serial number, HHWV = hardware version gauge, GSWV = software version gauge, sensor data set, BSWV = Bluetooth software version, BADR = Bluetooth MAC address, BFCC = Bluetooth FCC certification and B_IC = Bluetooth IC certification.

11.2.24 Table of basic settings for MiniTest 4500

MiniTest 4500		
1	BLOCKSIZE	**1** , 2 … 99
2	BACKLIGHT	20% 40% 60% 80% **100%**
3	KEYBOARD LIGHT	**AUTO** OFF ON
4	SOUND	**ON** OFF
5	CLOCK	**24h** AM/PM
6	TIME/DATE	HOUR MINUTE / YEAR MONTH DAY
7	UNIT	**AUTO µm** / FIX µm / FIX mm / FIX cm / AUTO mils / FIX mils /FIX inch
8	AUTO LOGGING	**OFF** 1/SEC 2/SEC 5/SEC 10/SEC 20/SEC
9	TIMESTAMP	**ON** OFF
10	COLOR READING	NONE / 1 / 2 / 3 / 4 / 5 / **6** / 7
11	COLOR HI-LIMIT	NONE / 1 / 2 / 3 / **4** / 5 / 6 / 7
12	COLOR LO-LIMIT	NONE / **1** / 2 / 3 / 4 / 5 / 6 / 7
13	ALARM READING-TIME	OFF / **50ms** / 100ms / 150ms / 200ms / 250ms / 300ms / 350ms / 400ms / CONTINUOUS
14	ALARM HI-LIMIT	OFF / 50ms / 100ms / **150ms** / 200ms / 250ms / 300ms / 350ms / 400ms / CONTINUOUS
15	ALARM LO-LIMIT	OFF / 50ms / **100ms** / 150ms / 200ms / 250ms / 300ms / 350ms / 400ms / CONTINUOUS
16	FOOTSWITCH MODE	**SAVE** / DELETE
17	BLUETOOTH PRINTER	…
18	DATA OUTPUT	USB / RS232 / BT-PRINTER / BT-PC / **OFF**
19	DATA STORAGE	COMMA µm / **DOT µm** / COMMA mils / DOT mils / OFF
20	SENSOR INIT	
21	POWER SUPPLY	**BATTERY** ACCUMULATOR
22	POWER OFF	1 MIN / **5 MIN** / 10 MIN / 30 MIN / OFF
23	SYSINFO	GTYP / GSER / STYP / SSER / HHWV / GSWV / SDSV / BSWV / BADR / BFCC / B_IC

11.2.25 Table of basic settings for MiniTest 2500

MiniTest 2500		
1	BLOCKSIZE	**1** , 2 … 99
2	BACKLIGHT	20% 40% 60% 80% **100%**
3	KEYBOARD LIGHT	**AUTO** OFF ON
4	SOUND	**ON** OFF
5	CLOCK	**24h** AM/PM
6	TIME/DATE	HOUR MINUTE / YEAR MONTH DAY
7	UNIT	**AUTO µm** / FIX µm / FIX mm / FIX cm / AUTO mils / FIX mils /FIX inch
8	COLOR READING	NONE / 1 / 2 / 3 / 4 / 5 / **6** / 7
9	ALARM READING	OFF / **50ms** / 100ms / 150ms / 200ms / 250ms / 300ms / 350ms /400ms / CONTINUOUS
10	FOOTSWITCH MODE	**SAVE** / DELETE
11	DATA OUTPUT	USB / RS232 / **OFF**
12	DATA STORAGE	COMMA µm / **DOT µm** / COMMA mils / DOT mils / OFF
13	SENSOR INIT	
14	POWER SUPPLY	**BATTERY** ACCUMULATOR
15	POWER OFF	1 MIN / **5 MIN** / 10 MIN / 30 MIN / OFF
16	SYSINFO	GTYP / GSER / STYP / SSER / GHWV / GSWV / SDSV /

12. Accessories

12.1 General

The coating thickness gauge MiniTest 4500 can optionally be equipped with a 7-pole multi-connector offering to connect the following accessories

It is not possible to connect several items simultaneously

RS 232C cable

Foot switch. In order to transfer data to the memory when working in measuring mode “continuous“ (see section 11.2.16).

The multifunction output with:

- an RS232 compatible interface,
- a footswitch input for connecting a footswitch or external switch contact,
- an alarm output for connection of an optical or acoustic warning device.

Electrical connection information:
Voltage: 3.6V
Impedance: 270 ohms

13. Care and maintenance

13.1 Care

Clean the gauge, sensor and accessories with a damp cloth. Use water or a mild detergent.

Attention:

Do not use any solvents or acids to clean to clean the plastic parts as they might be damaged or get brittle.

Do not use any metal objects (tools or brushes) to clean the sensor pole in order to avoid damages.

13.1.1 Using NiMH rechargeable batteries

To achieve optimal service life of the NiMH rechargeable batteries please respect the following instructions:

- Before the first use, the NiMH rechargeable batteries should be discharged and recharged in three subsequent cycles in order to ensure their maximum capacity. This procedure is also recommended to restore the full capacity of used rechargeable batteries.
- If the MiniTest will not be used a longer period of time, remove the NiMH batteries before storing the gauge. Please note that even if the gauge is switched off, a faint current will flow which as a consequence will lead to deep discharge after some time. Deep discharge might destroy batteries and must be prevented in any case.
- For extended storage periods (more than six months) NiMH rechargeable batteries must be kept in charged state. In addition, it is recommended to reload at least once a year. Recommended battery storage temperature: form +10 ºC to +30 ºC at a relative air humidity of 50%.

- Try to save battery life e. g. by operating the MiniTest in auto switch-off mode, instead of continuous service. This is to avoid current consumption if the gauge is idle for a while.

13.2 Maintenance

Generally, no maintenance work is required for doating thickness gauges of the MiniTest 4500 series.

Note:

Repairs may only be carried out by authorized ElektroPhysik staff.

14. Technical data

14.1 Gauge specification

Technical data

	MiniTest 2500	MiniTest 4500
Data memory of MiniTest		
- Total number of storable readings	2.000.000	2.000.000
- Max. number of batches	1	9801
- Number of application memories for batches with individual calibration	-	99
- Number of BATCHES per application memory for batches with identical calibration	-	99
Statistical functions (per batch)	- Single value statistics: $\bar{x}$, σ, kvar, n, max., min. - Block value statistics: $\bar{x}$, σ, kvar, n, max., min.	- Single value statistics: $\bar{\bar{x}}$ σ, kvar, n, max., min., CP, CPK - Block value statistics: $\bar{\bar{x}}$, σ, kvar, n, max., min., CP, CPK
Calibration	Factory settings, Zero and up to 4 calibration points,	
		Calibration through coating if the base material is not accessible (CTC)
Offset function	-	For addition or subtraction of a constant value to/from a reading
Limit settings (user definable) with monitoring function	-	Optical and acoustical alert when a limit is exceeded
Measuring units	µm, mm, cm, mils, inch	
Data interface	USB	USB and Bluetooth 4.0
Power supply	3 x AA (LR06) batteries, optional viaUSB	
Working time per battery set	approx. 150 hours (without illumination)	
Norms and standards	DIN EN ISO 1461, 2064, 2178, 2360, 2808, 3882, 19840; SSPC-PA 2, IMO MSC, ASTM B 244, B 499, D 7091, E376	
Display	53 x 46 mm, backlit	
Operating temperature	–10 °C … 60 °C / 14°F … 140°F	
Storage temperature	–20 °C … 70 °C / -44°F … 158°F	
Dimensions	153 mm x 89 mm x 36 mm / 6” x 3.5” x 1.4”)	
Protection class	IP65	
Weight	320 g / 0.7 lbs (Gauge incl. batteries) 90 g / 0.2 lbs Rubber protection case	

14.2 Sensor specifications

F-Sensors (magnetic induction principle)

Sensor	Range	Low range resolution	Measuring uncertainty on ElektroPhysik standards in laboratory environment	Min.Radius of curvatore (convexe/ concave)	Min. measuring area	Min. substrate thickness	Dimensions in mm
F05	0...500 µm	0,1 µm	± (1% of reading + 0,7 µm)	0,75 mm / 5 mm	Ø 3 mm (using a precision support)	0,1 mm	Ø 12 x 79
F1.6	0...1600 µm	0,1 µm	± (1% of reading + 1 µm)	1,5 mm / 10 mm	Ø 5 mm	0,5 mm	Ø 15 x 92
F3	0...3000 µm	0,2 µm	± (1% of reading + 1 µm)	1,5 mm / 10 mm	Ø 5 mm	0,5 mm	Ø 15 x 92
F1.6/90 Internal tube sensor	0...1600 µm	0,1 µm	± (1% of reading + 1 µm)	flat / 6 mm	Ø 5 mm	0,5 mm	8 x 11 x 180
F1.6P Powder probe	0...1600 µm	0,1 µm	± (3% v. Messwert + 1 µm)	Only on flat srufaces	Ø 30 mm	F 0,5 mm N 0,5 mm	Ø 21 x 89
F2/90 Internal tube sensor	0...2000 µm	0,2 µm	± (1% of reading + 1 µm)	flat / 6 mm	Ø 5 mm	0,5 mm	8 x 11 x 180
F10	0...10 mm	5 µm	± (1% of reading + 10 µm)	5 mm / 16 mm	Ø 20 mm	1 mm	Ø 25 x 46
F20	0...20 mm	10 µm	± (1% of reading + 10 µm)	10 mm / 30 mm	Ø 40 mm	2 mm	Ø 40 x 65
F50	0...50 mm	10 µm	± (3% of reading + 50 µm)	50 mm / 200 mm	Ø 300 mm	2 mm	Ø 45 x 70

N-Sensors (Eddy current principle)

Sensor	Range	Low range resolution	Measuring uncertainty on ElektroPhysik standards (laboratory cond.	Min.Radius of curvature (convexe/ concave)	Min. measuring area	Min. substrate thickness	Dimensions in mm
N.08 Cr	0...80 µm	0,1 µm	± (1% of reading + 1 µm)	2,5 mm / 10 mm	Ø 5 mm	≥100 µm for Cu on Fe	Ø 16 x 99
N 02	0...200 µm	0,1 µm	± (1% of reading + 0,5 µm)	1 mm / 5 mm	Ø 0,2 mm	50 µm	Ø 16 x 99
N 1.6	0...1600 µm	0,1 µm	± (1% of reading + 1 µm)	1,5 mm / 10 mm	Ø 5 mm	50 µm	Ø 15 x 22
N1.6/90 internal tube sensor	0...1600 µm	0,1 µm	± (1% of reading + 1 µm)	flat / 6 mm	Ø 5 mm	50 µm	8 x 11 x 180
N2/90 internal tube sensor	0...2000 µm	0,2 µm	±(1% of reading + 1 µm)	flat / 6 mm	Ø 5 mm	50 µm	8 x 11 x 180
N10	0...10mm	10 µm	± (1% of reading + 25 µm)	25 mm / 100 mm	Ø 50 mm	50 µm	Ø 60 x 50
N20	0...20 mm	10 µm	± (1% of reading + 50 µm)	25 mm / 100 mm	Ø 70 mm	50 µm	Ø 65 x 75
N100	0...100 mm	100 µm	± (3% of reading + 0,3 mm)	100 mm / flat	Ø 200 mm	50 µm	Ø 126 x 155
CN02 Cu-coatings on insulating substrate	10...200 µm	0,2 µm	± (3% of reading + 1 µm)	Only on flat surfaces	Ø 7 mm	none	Ø 17 x 80

Universal sensors (magnet induction and eddy current principle)

Sensor	Range	Low range resolution	Measuring uncertainty on ElektroPhysik standards (laboratory cond.	Min.Radius of curvature (convexe/ concave)	Min. measuring area	Min. substrate thickness	Dimensions in mm
FN1.6	0...1600 µm	0,1 µm	± (1% of reading + 1 µm)	1,5 mm / 10 mm	Ø 5 mm	F 0,5 mm N 50 µm	Ø 15 x 62
FN1.6P	0...1600 µm	0,1 µm	± (3% of reading + 1 µm)	nur flate Flächen	Ø 30 mm	F 0,5 mm N 0,5 mm	Ø 21 x 89
FN 1.6/90 internal tube sensor	0...1600 µm	0,1 µm	± (1% of reading + 1 µm)	flat / 6 mm	Ø 5 mm	F 0,5 mm N 50 µm	8 x 11 x 180
FN2/90 internal tube sensor	0...2000 µm	0,2 µm	± (1% of reading + 1 µm)	flat / 6 mm	Ø 5 mm	0,5 mm	8 x 11 x 180

[1] referring to multi-point calibration using ElektroPhysik standards in laboratory conditions
[2] bei Zero Calibration sowie der Calibration auf einer Schicht in der Nähe der zu erwartenden Schichtdicke.
[3] using a precision support
[5] nach DIN 55350 Teil 13
[6] durch Mehrpunktcalibration können auch bessere als die spezifizierten Daten realisiert werden
[7] inklusive Beschichtung
[8] wenn das Messobjekt hinsichtlich Material, Geometrie and Rauheit der mitgelieferten Referenz-Nullplatte entspricht.

14.3 Standard supply

14.3.3 Coating thickness gauge MiniTest 2500/ 4500 with interchangeable sensor

Description	**Part no.**
MiniTest 4500, Basic unit **without** sensor	80-144-0000
including: - Plastic carrying case for transport and storage - Rubber protection case - USB cable with mains plug (EU type) - Manual on CD-Rom in German, English and French - 3 batteries 2 x AA (Mignon)	
MiniTest 2500, Basic unit **without** sensor	80-143-0000
including: - Plastic carrying case for transport and storage - Rubber protection case - USB cable with mains plug (EU type) - Manual on CD-Rom in German, English and French - 3 batteries 2 x AA (Mignon)	

14.3.4 Interchangeable sensors for MiniTest 2500/4500

Description		**Part no.**
Sensor for non-magnetic coatings on magnetic steel, also on steel alloys and hardened steel (magnetic induction principle)	F05	80-0A0-1202
	F 1.6	80-0A1-1603
	F 2 probe for high temperatures up to 250 °C	80-0A1-1202
	F 2 probe for high temperatures up to 350 °C	80-0A1-1302
	F3	80-0A1-1403
	F 1.6/90	80-0A4-1200
	F 2 /90	80-0A4-1300
	F 10	80-0A6-1001
	F 20	80-0A8-1001
	F 50	80-0AA-1000
Sensor for insulating coatings on non-ferrous metals and on austenitic steel (eddy current principle)	N .08 Cr	80-0A2-1101
	N 02	80-0A2-1001
	N 1.6	80-0A3-1302
	N 1.6/90	80-0A5-1200
	N 2/90	80-0A5-1300
	N 10	80-0A7-1000
	N 20	80-0A9-1000
	N 100	80-0B1-1000
Universal sensors combining both principles	FN 1.6	80-080-1402
	FN 1.6/90	80-082-1000
	FN 2/90	80-082-1100
Each sensor is supplied with a set of precision standards.		

14.4 Accessories

Description	Part no.
Data printer MiniPrint 7000 incl. charger	70-171-0002
Thermo paper roll 58 x ∅31mm for MiniPrint 7000	06-007-0007
Quick charger for NiMH batteries	02-070-0001
NiMH rechargeable batteries Mignon AA HR6 1,2V (3 pieces required)	02-064-0001
Batteries Mignon AA LR6 1,5V (3 pieces required)	02-064-0008
Precision support for stable probe positioning on small objects	80-900-0220
Adaptor to connect sensor F 05 to precision support	80-900-0233
Foot switch	80-901-1700
Precision standards (see separate list)	
MSoft 7000 basic Data transfer software	80-901-1600
Manufacturers certificate according to DIN 55350 M for coating thickness gauge MiniTest 2500 / 4500 incl. one sensor	41-130-0000
Manufacturers certificate according to DIN 55350 M for precision standards (basic price)	41-050-0000
Certification per standard	41-050-0001

15. Annexe

15.1 Error messages and trouble shooting

Error message	
E 1:	Sensor not compatibe.
E 2:	No sensor connected. This error message is displayed when no sensor is connected after a total reset.
E 3:	Sensor defective. Displayed either when gauge is switched on or if the sensor has been disconnected during operation.
E 4:	Sensor supplies instable measuring values (for example due to strong magnetic fields in the surroundings or when measuring on very soft material).
E 5:	Sensor too close to metal when gauge was switched on.
E 6:	Battery voltage low. .
E 11:	Data memory saturated. .
E 12:	Zero calibration not permitted. .
E 13:	CTC- calibration not permitted.
E 14:	2 point calibration (using two calibration foils) calibration not permitted.
E 15:	1 point calibration not possible after CTC calibration.
E 16:	The application selected is already assigned to another sensor or sensor had been repaired.
E 17:	Sensor not initialized
E 18:	BT-Device not found
E 19:	BT-Connection -Fail
E 20:	CALIBRATION FAIL
E 21:	SD Card FAULTY
E 22:	FILE ERROR

Following troubles can be remedied by carrying out a total reset (see Section 11.1).

- Gauge does not react to pressure of a key.
- Gauge does not allow further measurements.
- Illogical values on displayAnzeigewerte.

In case the gauge can not be reset using the ON/OFF key, shortly take out and reinsert batteries.

15.2 Statistical terms

Statistical evaluation is helpful to assess the quality of the product.

Mean value

Mean value $\bar{x}$ is the sum of single readings dvided by the total number of readings. .

$$\bar{x} = \frac{\Sigma x}{n}$$

Variance

The variance of a list is the square of the standard deviation of the list, that is, the average of the squares of the deviations of the numbers in the list from their mean divided by the (number of readings minus 1).

$$\mathrm{var} = \frac{\sum (x - \bar{x})^2}{n - 1}$$

Standard deviation s **(s = σ = sigma)**

The sample standard deviation is a statistic that measures how “dispersed“ the sample is around the sample mean. The sample standard deviation increases with increasing spread out. The standard deviation of a set of numbers is the root mean square of the variance s².

$$s = \sqrt{\mathrm{var}}$$

Variation coefficient (Var.-Coeff.)

The Variation coefficient is the standard deviation divided by the arithmetic mean. The variation coefficient is indicated in percent.

$$K\,\mathrm{var} = \frac{s}{\bar{x}} \times 100\%$$

15.3 Safety notes

Safe operation will be ensured as far as the instructions and notes in this manual and on the gauge display will be observed.

For installation work, please cut power supply. Use only original spare parts and/or accessories!

Only use original parts for replacement and accessories.

	**Accessories and rechargeable batteries**Make sure to use only original accessories and batteries. supplied/recommended by the manufacturer of gauge. Connect only to compatible peripheral devices.
	**Connecting other devices** If you connect the gauge to another device, please refer to the corresponding instructions manual for detailed information on safety issues. Do only connect original accessories recommended by the manufacturer of the MiniTest 4500 series.
	**Keep away from water** The measuring unit is not waterproof. Keep in a dry place.
	**Keep away from explosion-hazardous area**
	**Approved after-sales service** The gauge may only be repaired by approved and qualified after-sales service staff.
	**Medical facilities** Please ask for permission before using the gauge in medical facilities

15.4 Declaration of conformity according to EU directive

We, ElektroPhysik Dr. Steingroever GmbH & Co. KG, Pasteurstr. 15, 50735 Cologne, Germany,declare in sole responsibility that the products coating thickness gauges MiniTest 2500, MiniTest 4500 to which this declaration relates are in conformity with the provisions of following EU directive

2014/30/EU (Electromagnetic compatibility) dated 26th February 2014

2014/53/EU (RED) dated 16th April 2014

2011/65/EU (RoHS) dated 8th June 2011
2012/19/EU (WEEE) dated 4th July 2012 registration number 66544799

.

15.5 Return of used equipment

In order to comply with the European Directive on Waste Electrical and Electronic Equipment 2012/19/EU (WEEE) dated 4th July 2012 implemented through national law ElektroG 2015 (ElektroG2) please return gauges out of use to the manufacturer:
ElektroPhysik

Dr. Steingroever GmbH & Co. KG

Pasteurstr. 15

D-50735 Cologne, Germany

15.6 Service-Adressen

ElektroPhysik coating thickness gauges are manufactured according to state-of-the-art production methods using high-class components. Careful production controls along with a Certified Quality Management according to DIN EN ISO 9001 ensure optimum product quality

In case of errors please contact ElektroPhysik or your local dealer. If repairs should become necessary, please send the gauge to ElektroPhysik or contact your local ElektroPhysik representative for return and repair instructions..

Please note that the gauge should only be repaired by authorized, skilled and trained personnel. Service attempts by untrained personnel could cause extensive damage to the gauge and possibly void any and all warranties. Please retain original packing for returning the gauge in case of repair.

For more detailed information on the use, applications, service or technical data, please contact ElektroPhysik or your local ElektroPhysik representative:

ElektroPhysik

Dr. Steingroever GmbH & Co. KG

Pasteurstr. 15

D-50735 Cologne, Germany

Tel.: +49 221 75204-0

Fax: +49 221 75204-69

E-Mail: info@elektrophysik.com

For company details of ElektroPhysik representative in your country please click on.

http://www.elektrophysik.com/company/agents/index.html

16. Change history

This section includes changes (if any).

17. Index

Acoustic signal....51
Alarm signal....53
Average....68
Base material....8
Batch....24, 51
Batteries....9, 12, 25, 66
Battery level....12
Battery mode....54
Blasted surfaces....40
Block size....41
Calibration....24, 25, 40
  Calibration method....21
  Calibration methods....10, 25
  Factory calibration....10
  Factory presettings....25
  Two-point Calibration....25, 26
  Zero Calibration....25
Cleaning....59
Configuration....48, 49
Data....55
  Data output....52
  Data transfer....54
Data memory....52
Data output to interface....54
Date....51
Display....51
  Illumination....51
First operation....10
First use....50
Identification data....55
Initialization....50
ISO....71
Limits....41
Mean value....68
Measurement....20
Measuring mode....10, 24
Measuring principle....20, 44, 45, 65
Measuring units....52
Measuring values....24, 52, 68
Memory....17
Offset....41
Operating elements....12
Permanent operatoin....55
Precision standard....24, 26
Readings....50
Rechargeable batteries....9, 12, 13, 25, 59, 66, 69
Rough surfaces....40
Series of measurement....15
Standard deviation....68
Standard supply....12, 65
Substrate....25, 26
Switch off....12
  automatic....59
Switch on....12, 15
Terminal program....48
Time....51
Total Reset....67
Transfer rate....52
USB Interface....44, 48
Variance....68
Variation coefficient....68