Operator‘s Manual

FISCHERSCOPE® MMS® PC2

FISCHERSCOPE® MMS® PC2

The universal instrument for coating thickness measurement and material testing

Document order number		Issue date
902-521		12/2015

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On our home page www.helmut-fischer.com you will find the addresses of our sole agencies and subsidiary companies around the globe.

Quality Assurance System of the Helmut Fischer GmbH

DIN ISO 17025	Calibration lab with DKD accreditation according to DIN ISO 17025 for certified mass per unit area standards
ISO 9001:2008	Certified according to ISO 9001:2008 German Lloyd Certification

S Safety information

If you use the instrument as intended and observe the safety information, the instrument poses no danger.

Read and follow these instructions and observe the safety information. Also observe generally applicable safety and accident prevention regulations.

S.1 Read the operator's manual carefully before operating

- Make sure to read this operator's manual carefully before taking the instrument into operation.
- Keep the manual in a safe place, so that you will be able to consult it whenever necessary.

S.2 Warnings used

	ATTENTION	Indicates a danger that can lead to **damage** or **destruction** of the **product**.
	CAUTION	Indicates a danger that can lead to **minor or moderately severe injuries**.
	WARNING	Indicates a danger that can lead to **fatal or severe injuries**.
	DANGER	Indicates a danger that can lead **immediately** to **fatal or severe injuries**.

S.3 Symbols used

	Note Indicates important information and notes.
	Caution, indicates warnings of damage to the instrument or loss of data.

S.4 Intended use

The measuring system FISCHERSCOPE MMS PC2 is used solely to measure the coating thickness, the electrical conductivity and the ferrite content depending of the modules equipped in the instrument.

Only accessories approved or recommended by the manufacturer may be connected to the instrument.

Any use beyond this is not the intended use. The risk of damage ensuing therefrom is borne solely by the user.

S.5 Safety of the electrical equipment

EMC

The instrument complies with the law on the electromagnetic compatibility of apparatus (2014/30/EC). The measured values are not influenced by the maximum values of the types of interference listed in standard EN 61000-6-2 (which refers to standards EN 61000-4-2, EN 61000-4-3 and EN 61000-4-4).

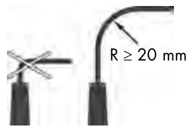
Low voltage

The instrument complies with the Low-Voltage Directive 2014/35/EC.

Product safety

The FISCHERSCOPE MMS PC2 is a product as defined by the Product Safety Act.

Probe connection cable

ATTENTION	**Wire breakage** Bending the probes and other connection cables sharply can cause broken wires. It is then no longer possible to measure. ► Roll the probe connection cable into a radius of at least 20 mm (0.79 inch). ► Do not kink or pinch connection cables. 

S.6 Servicing and repairs

Modifications, repairs as well as maintenance and service work on the instrument and accessories may be carried out only by service personnel authorised by the manufacturer.

S.7 Ambient conditions

Ambient temperature during operation: 0 … +40 °C (+32 … +104 °F)

Storage and transport temperature: +5 … +60 °C (+41 … +140 °F)

ATTENTION	**Risk of damage to the instrument from excessively high temperatures** When exposed to sunshine, the areas behind glass windows (e.g. in an automobile) can easily reach temperatures in excess of +60 °C (+140 °F). This can damage the instrument. ► Do **not** leave or store the instrument and accessories behind glass windows or next to heat sources such as radiators etc.!

ATTENTION **Risk of damage to the instrument from acid**

The instrument and accessories are **not acid-resistant**.

► Do **not** bring the instrument and accessories into contact with acids or acid containing liquids!

ATTENTION **Hazard of short-circuit**

The hazard of a short circuit exists if the instrument and accessories (especially the AC adapter) come into direct contact with liquids!

► Operate, leave or store the instrument and accessories only at locations with a relative humidity of 30 % to 90 % (non-condensing).

ATTENTION **The instrument and accessories are not suitable for use in potentially explosive environments.**

► Do **not** operate the instrument and accessories in potentially explosive areas!

ATTENTION **Risk of damage to the instrument from electrostatic charge**

Electrostatic charges can damage components in the instrument or erase the memory in the instrument.

► Earth individuals who connect the probe to the instrument.

► Connect or plug in the probe only when the instrument is switched off!

► We recommend that the instrument be stored with the probe connected.

S.8 Probe Types ESL08

CAUTION **Risk of injury at the probe tip**

When handling the probe you can easy injure yourself or other people with the probe tip!

► Hold the probe tip always away from your body.

► Do not leave about the probe.

► When not in use, always place the red protective cap on the probe foot.

ATTENTION **Breakage of the probe tip**

The small probe tip is very sensitive to mechanical stress.

► Do not try to straighten a bent probe tip! This will inevitably lead to breakage of the probe tip!

► Replace bent probe tip.

ATTENTION	**Damage of the probe** The probe tip is not acid-proof and can be damaged by acid wetting! ► Do **not** bring the probe into contact with acids or acid containing liquids! ► Carefully remove electrolyte residue from the circuit board prior to making measurements!

S.9 Beta Sources - Safety Regualtions

Working with Beta isotopes is subject to radiation protection regulations. Despite this, in practically all countries in the world, anyone working with radioactive material has to have a license to do so. In most cases, before a license is issued, the user must fulfill certain conditions laid down by the appropriate regulatory authority. The extent and strictness off such safety regulations differs from country to country. If you are in doubt as to the regulations in your country, get in touch with your local regulatory authority or with your local Fischer representative.

Only specially trained personnel are permitted to work with Beta isotopes!

It is imperative to observe the enclosed 'Instructions for handling aperture rings (platens), and calibration standards' !!

S.10 Disposal

	**Disposal** Do not dispose of waste electrical equipment and electronic accessories with household refuse. ► Put damaged or used batteries, waste electrical and electronic equipment in the appropriate collection bins! Please observe the regulations in your region for proper handling of waste electrical equipment and electronic accessories.

1 FISCHERSCOPE® MMS® PC2 - Overview

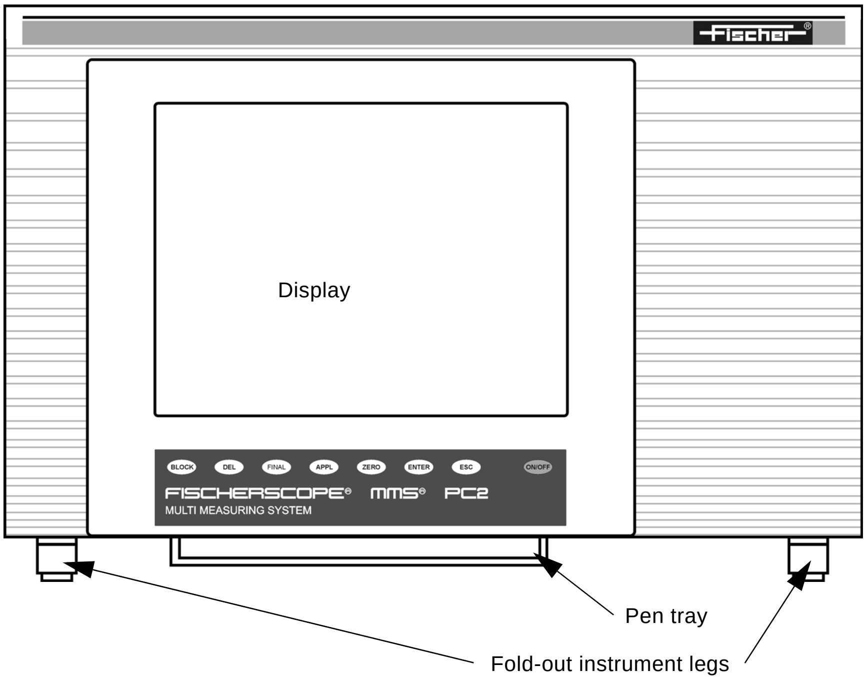
Measurements of the various quantities, coating thickness, electrical conductivity and ferrite content require diffenrent measurement methods. For coating thickness measurements, again different measurement methods may be employed depending on the coating/substrate material combination. The FISCHERSCOPE® MMS® PC2 features a modular design to satisfy this multitude of applications and is thus individually configurable. The instrument is equipped with the required module board corresponding to your measurement application. Module boards for various measurement methods are available to measure the coating thickness of various coating/substrate material combinations.

The probe that corresponds to your measurement application is connected to the module board. The probe contains the sensing element. The measurement signal from the sensing element is converted in the corresponding measurement value. Fischer provides a broad assortment of probes for varying measuring applications. The diversity of task requires the use of probes that differ in shape and construction.

The instrument FISCHERSCOPE® MMS® PC2 and the connected probe form a measurement system to measure e.g., the coating thickness.

1.1 Instrument Description

1.1.1 Front panel of the FISCHERSCOPE® MMS® PC2



Description of the instrument keys

Block
Calls the block result.

DEL

- Deletes the last measured reading.
- Hiding and viewing of any measurement reading (except of the last reading).

FINAL
Calls the final result.

ZERO
Calls the normalization function. 🗐 For the procedure see the respective chapters 2.9 to 2.14 of this manual.

ENTER
Confirms inputs/selections in dialog windows. Closes dialog windows with the displayed settings. Corresponds to the **OK** control button in the dialog windows.

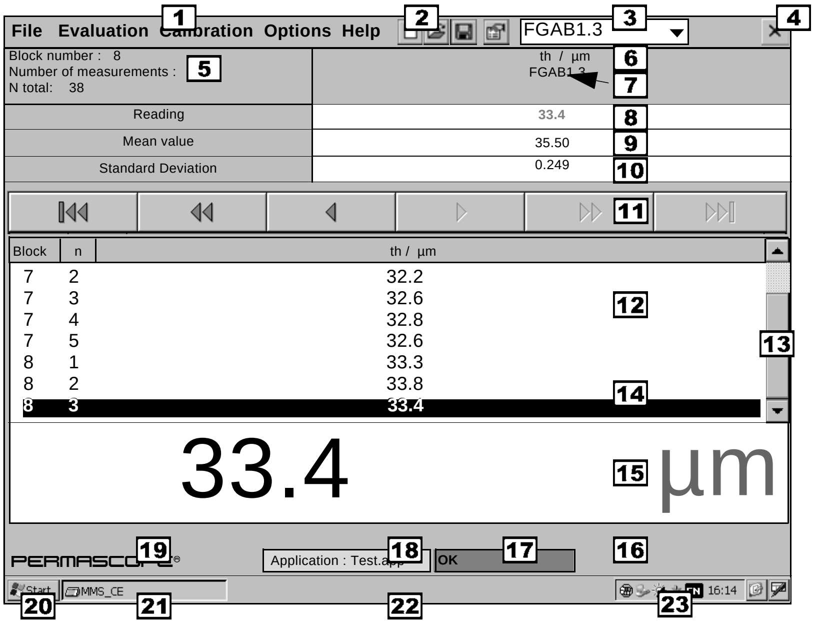
APPL
Opens a window for selecting the application files in the "Fischer Application" directory.

ESC

- Closes the dialog window without accepting the changed settings. Corresponds to the **Cancel** control button in the dialog windows.
- Exits the block result or final result and automatically places a block closure. The next measurements will be written to a new block.
- Application with automatic block creation: Exits the block result or final result without placing a block closure.

ON/OFF
Switches the instrument On and Off. After powering up the instrument, the measurement and evaluation program MMS_CE opens automatically after a brief loading period.

Description of the display, measurement mode Numeric Display



Example

1 Menubar

2 File toolbar

3 Designation of the connected measurement probe

4 Exit program

5 Current block number (measurements can be separated into blocks) / number of measurements of the current block / total number of measurements of the open application file

6 Measurement data display / selected measurement unit

7 Probe that was used to set up the application file.

8 Marked measurement

9 Mean value of the displayed block

10 Standard deviation of the mean value

11 Measurement-related toolbar

12 Display of the single readings with numbering and assignment to the block

13 Scroll bar, appears if not all single readings can be shown on the display.

14 Cursor, automatically highlights the last reading

15 Marked measurement with unit of measurement

16 Status bar

17 Measurement readiness

18 File name (example Test.app)

19 Used measurement method

20 Start menu (not relevant for the measurement operation)

21 Program window MMS_CE

22 Task bar

23 Autostart display

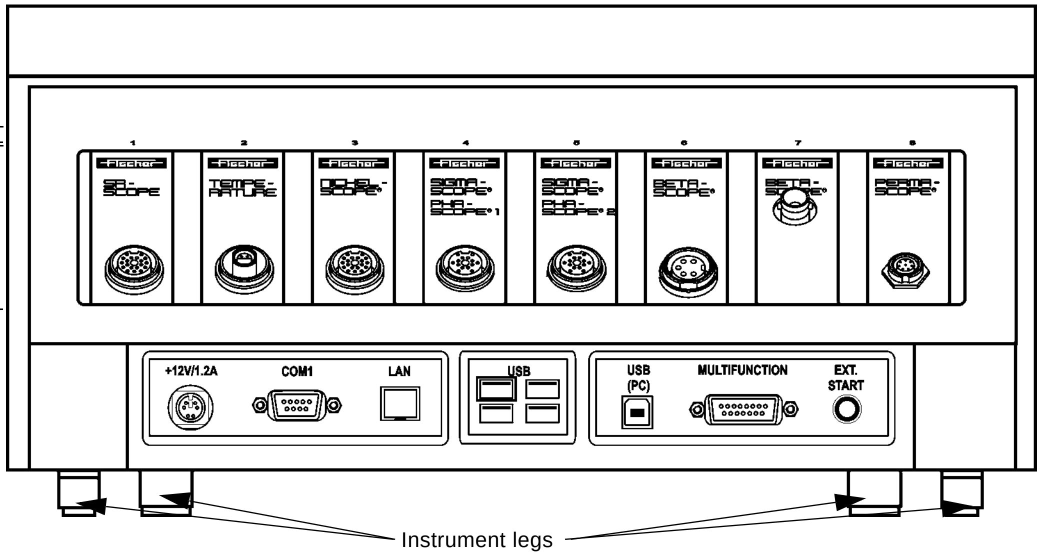
1.1.2 Rear panel of the FISCHERSCOPE® MMS® PC2

Description of the instrument connections

Rear view of the insrument

Numbers of the module board slots (1 - 8)

Module boards for measurements using various measuring methods. Selection and population are determined by the required measurement applications. An overview of the available module boards 1-6.



Probe connections

Each module board has a probe connection.

COM1

RS232 port for data transfer or for connecting, e.g., a motor driven support stand V12-AM, a programmable xy-stage or a electronic gauge; 9-pin SUB-D socket; connector pin-out 1-5.
To set data transmission format and mode, go to **Options/Options**, tab *COM Paramater*.
To select data output to the COM port, go to **Options/Options**, tab *COM Port*.

USB

4 USB ports for printer, commercial USB pc keyboard, USB memory sticks, HUB and external hard disk; 2.0 compatible; further information 6-3.
Settings for connected printer:
to select printer type, go to **File/Print**
to select data output, go to **Options/Options**, tab *Printer Output*

+12V/1.2A

Connection for the power supply. Socket for the plug of the line adapter (included with the instrument).

LAN

Integrating the instrument into a Ethernet network. For central data storage and direct data access on a network.

USB (PC)

Connection for an PC via USB (connecting cable including delivery); 2.0 compatible; USB port with Function mode. further information 6-9.
To select operation mode, go to **Options/Options**, tab *COM Parameter*.

MULTIFUNCTION

Multifunction connection with signal outputs for upper and lower limit violations and external triggering of measurement accept (External Start); 15-pin SUB-D socket; connector pin-out 1-5.

EXT. START

Connection for external trigger of measurement accept, jack socket.
The contact for external triggering of measurement accept must be designed as a non-locking key. The control button may be used as well. Foot switch on request.
To set measurement accept to External Start, go to **File/Properties**, Tab *Trigger*.

It is imperative to observe the section "Connection Instructions" for the instrument connections! 1-8.

Plug Pin-Out

COM1
RS232 interface

COM1 Port
RS232 Port COM1, 9-pin SUB-D socket

Pin-out:

Pin 1 not used	Pin 5 GND
Pin 2 R x D (Receive Data, ←)	Pin 6 DSR (Data Set Ready, ←)
Pin 3 T x D (Transmit Data, →)	Pin 7 CTS (Clear To Send, ←)
Pin 4 DTR (Data Terminal Ready, →)	Pin 8 RTS (Request To Send, →)
	Pin 9 not used

- Use our ActiveSync interface connection set for connecting to a PC. A non-twisted connection cable must be used.
- The setting of the data format is done from **Options/Options**, Tab *COM Parameter*. 6-17
- The setting of which data are to be output to the COM port is done from **Options/Options**, tab *COM Output*. 6-20

MULTIFUNCTION
Multifunction connection

Multifunction connection
MULTIFUNCTION, 15-pin SUB-D socket

Pin-out:

Pin 1	Air value measurement	Pin 8	Signal output for measurement is below the lower limit
Pin 2	not used		
Pin 3	not used	Pin 9	not used
Pin 4	External Start	Pin 10	not used
Pin 5	Measurement pulse	Pin 11	GND
Pin 6	Signal output for measurement is within the set limits	Pin 12	not used
		Pin 13	GND
Pin 7	Signal output for measurement is above the upper limit	Pin 14	not used
		Pin 15	GND

- The contact for external start must be designed as a non-locking key.
- All signal outputs provide a signal at TTL level (5 V/ 5 mA).

1.1.3 Module Board/Application Areas

Applications \ Module boards	PERMASCOPE®	BETASCOPE®	SIGMASCOPE® / PHASCOPE® 1	SIGMASCOPE® / PHASCOPE® 2	PHASCOPE® / DUPLEX	NICKELSCOPE®	SR-SCOPE®	TEMPERATURE	Measuring method
Coating thickness measurement - Electromagnetic methods									
Measurement of electr. non-conducting coatings on non-magnetizable metallic substrate materials.	●				●				ISOSCOPE® Amplitude sensitive Eddy current method DIN EN ISO 2360
Measurement of electr. non-conducting coatings on ferro-magnetic substrate materials (steel or iron).	●								PERMASCOPE® magnetic induction method DIN EN ISO 2178
Measurement of non-magnetizable coatings on ferro-magnetic substrate materials (steel or iron).	●				●				
Measurement of non-magnetizable coatings (Cu, Zn, Ni) on ferro-magnetic substrate materials (steel or iron).			●						PHASCOPE® Phase sensitive eddy current method DIN EN ISO 21968
Measurement of magnetic coatings with a high electrical conductivity on non-magnetic substrate materials with a low electrical conductivity.			●						
One-step measurement of the individual thicknesses of a paint/zinc coating system (duplex coating) on steel.					●				
Measurement of copper on pc-board material (Cu/Iso).			●						
Measurement of copper coatings in pc-board through-holes.			●						CU-SCOPE Phase sensitive eddy current method DIN EN ISO 21968
Measurement of the copper coating thickness on laminates or multi-layers, without influence of copper coatings below.							●	●	SR-SCOPE® Electrical resistance method DIN EN 14571

Module boards / Applications	PERMASCOPE®	BETASCOPE®	SIGMASCOPE® / PHASCOPE® 1	SIGMASCOPE® / PHASCOPE® 2	PHASCOPE® / DUPLEX	NICKELSCOPE®	SR-SCOPE®	TEMPERATURE	Measuring method
Measurement of electroplated nickel coatings on non-ferrous metals or electr. non-conducting substrate materials.						●			NICKELSCOPE® Magnetic method DIN EN ISO 2178
Measurement of non-ferrous metal coatings (Cu, Al, Pb) on ferro-magnetic substrate materials (steel or iron).						●			

Coating thickness measurement - Beta backscatter method

Measurement of synthetics or metal coatings.		●						●	BETASCOPE® Beta backscatter method DIN EN ISO 3543, ASTM B567, BS 5411
Measurement of oil or wax coatings on metals.		●						●	
Thickness inspection of foils, determination of the uniformity of fabrics.		●							

Conductivity measurement

Measurement of the electr. conductivity of non-ferrous metals.			●						SIGMASCOPE® Phase sensitive eddy current method DIN EN ISO 21968

Ferrite content measurement

Determination of the ferrite content in austenitic and duplex steel.	●								PERMASCOPE® magnetic induction method DIN EN ISO 2178

Temperature measurement									**Remarks**
Temperature measurement using the temperature sensor TF100 A (temperature sensor with Pt100 sensor).								●	Temperature measurement using a Pt100 sensor, Range -20 ºC (-4 °F) to +80 ºC (176 °F)

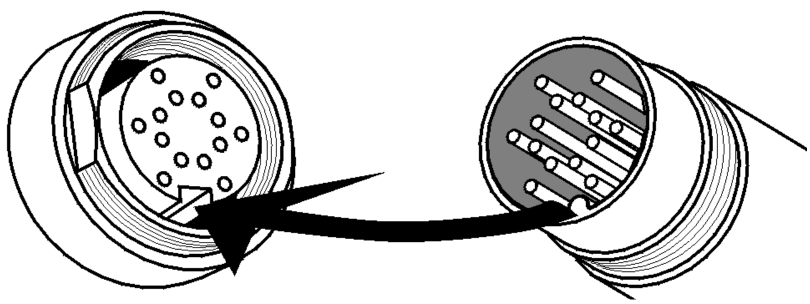
1.2 Connection Instructions

Connect probes only when the instrument is switched off!

- Avoids potential of electrical discharges.
- Otherwise, probe will not be recognized by the active application.

Instrument and accessories must be protected from static charge!
Electrical discharge can damage internal components or delete internal memories! Such discharges may occur, for example, when connecting the probe to the instrument. Thus, when connecting a probe ensure that the person who connects the probe is grounded. It is recommended to store the instrument with the probe connected.

1. Connecting the probe:



Instrument connection socket   Probe connection plug

When connecting the probe, ensure that the tongue of the plug fits into the groove of the socket! Do not attempt to insert the probe plug in any other manner; this would cause erroneous connections between the instrument and the probe or even damage the pins of the probe plug.

2. Use the knurled screw to screw the probe plug to instrument socket.

1.3 Switch the instrument on / off

- Press the orange colored **ON/OFF** key.
  The instrument recognizes the connected probe and shows the probe name on the display (top right).

If the open application (measurement application memory) has not been set up with this probe, a corresponding message will appear. “Missing” appears in a red field at the lower right display edge. Close the message window by tapping the **OK** button.

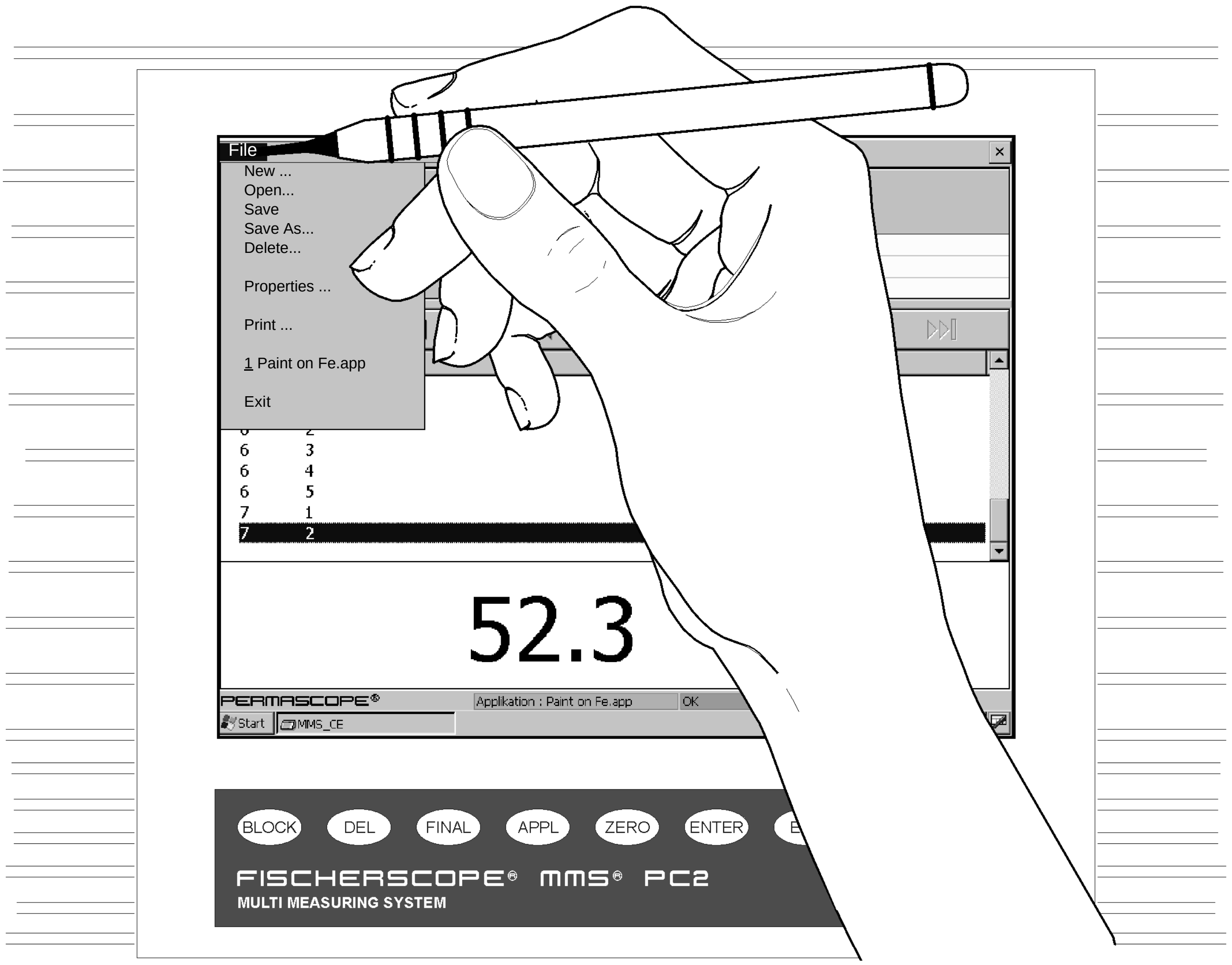
Depending on the connected probe, a normalization (system adjustment) must be performed after powering up the instrument or when opening the application. This is for purposes of the measurement uncertainty.

1.4 Instrument Operation with the Touch Screen

The operation of the instrument is mainly carried out by using the stylus (including delivery) on the touch screen. The stylus takes the function of a pc mouse. The touch screen recognizes the position of the stylus and enables so the navigation via display.

Procedure

- Tap directly with the stylus on the desired place on the display screen.
- Press the stylus with low pressure on the display screen to select, e.g., a parameter, menu command or character for text input and to activate a control button.



Tap menu command **File** on the display using the stylus. A pull down menu opens to select further sub menus.

Selecting parameters

Selecting parameters

Tap on the desired parameter using the stylus.
The setting will be executed or accepted into the application after finishing the menu function.

◉ Parameter enabled

○ Parameter disabled

Activating/Deactivating parameters

Tap directly into the box using the stylus.
The setting will be executed or accepted into the application after finishing the menu function.

☑ Activated setting

☐ Deaktivated setting

Grey colored parameters are not selectable in the current configuration.

◉ manual Example
○ automatic
○ Remaining time

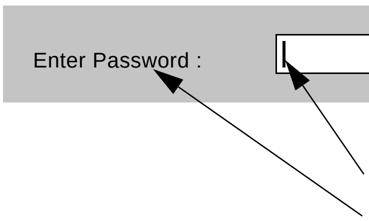
Opening a list box

Tap the icon ▼ using the stylus.
A selection list opens. For selection tap on the desired list entry. The selected list entry will be color highlighted.

Example for a list box: selecting the language of the program.

Entering text and numerical values

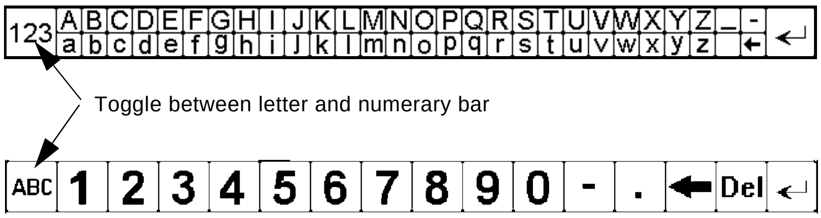
- If the cursor (= vertical line) flashing in the entry box you can make entries.
- To place the curor in the entry box: Double-tap in the entry box using the stylus.



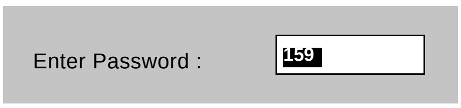
- Tap the letters in succession on the character bar at the bottom of the display with the stylus.

  The character bar appears automatically at the bottom of the display if entries of text or numeraries are required.

Character bar letters and numerary



- To highlight text/numeraries in the entry box: Double-tap in the entry box using the stylus or sweep the stylus over the characters.



Example

1.5 Control Buttons - Symbols - Menus

1.5.1 Control Buttons and Symbols

	File toolbar
	Set up new application (file), identical with the menu command **File/New**. Procedure 2-2, 3-2 and 4-2.
	Open the application (file), identical with the menu command **File/Open**. Procedure 2-20, 3-31 and 4-20.
	Save the open application (file), identical with the menu command **File/Save**. Procedure 2-21, 3-32 and 4-21.
	Set/Change or View the application-specific settings, identical with the menu command **File/Properties**.

	Program window
	Closes the dialog window.

	Task bar
	Calling the display keyboard for alphanumeric entries. The "Fischer Keyboard" is active. Large input bars at the lower display edge; letters and numbers separate. The "Keyboard" is active. Copy of the PC keyboard.
MMS_CE	Hide and show the program window.
13:55	Time of the instrument’s system clock.
EN	Indication of the language of the operating system. DE = German, EN = Englisch, FR = French, IT = Italien, ES = Spanish etc.
	Indication that the connection to the network is enabled (via LAN connector).
	Indication that no connection to the network is disabled.
	Calls a dialog window for adjusting contrast and brightness of the display.

	Task bar
	Connection PC - MMS® PC2 via USB port is enabled.
Start	Opens the WindowsCE Start menu. Not relevant for the measurement operation.

	USB (PC) port - connection modes - appears above the task bar
	Connection PC - MMS® PC2 via virtual COM Port (USB (PC) port). Further information 6-9. coloured icon: connection is active Grey icon: connection is not active
	Connection PC - MMS® PC2 via ActiveSync program (USB (PC) port). Further information 6-9. Couloured icon: connection is active Grey icon: connection is not active

	Measurement-related toolbar
	Move the cursor back one position, previous measurement.
	Move the cursor forward one position, next measurement.
	Move the cursor back block by block, previous block.
	Move the cursor forward block by block, next block.
	Move the cursor back to the first measurement/first block.
	Move the cursor forward to the last measured reading/last closed block.
	Calls block information. The instrument includes preset information parameters. Product information can be entered for each block, Procedure 5-3.
	No information available. For this block exist no product information.
	Measurement with temperature compensation. Required and available for set-up only for certain measurement methods and tasks, Further information 2-105, 3-27 and 4-6.
	Manual measurement start. The button appears only when the one of the following parameters was enabled from **File/Properties**, tab *Trigger*: **V12-AM** support stand or **XY-Table**. In connection with the BETASCOPE® module board: Starting the measurement.
	Manual measurement accept. Button appears only when the parameter **external start only** was enabled from **File/Properties**, Tab *Trigger*.

Measurement-related toolbar	
	Display block result
	Exits block result display without block closure.
	Calls the single readings of the displayed block.
	Calls the block information. IThe instrument includes preset information parameters. Product information can be entered for each block, procedure 5-3.
	No information available. For this block exist no product information.
	Print the displayed block result.
	Save the displayed block result in the file formats txt, htm or pdf.
	Exits block result display with a block closure. Button is not active for applications with set automatic block creation.

Dialog window for opening, saving and importing files (Applications)	
	Change directory.
	Set up a new directory.
	Copy the selected file to the clipboard.
	Insert the contents of the clipboard (file).
	Rename the selected file.

1.5.2 Menu Bar (Standard Menu)

The menu bar contains 5 main menus with various functions.

- The **File** menu contains functions that relate to the files (application, application memory, image file, etc.).
- The **Evaluation** menu contains presentations for the statistical measurement data evaluation and functions for measurement data selection and deletion.
- The **Calibration** menu contains all functions that are necessary for adjusting the measurement system (module board, probe) to the measurement application (= current specimen).
- The **Options** menu contains functions for the configuration of the instrument.
- The **Help** menu contains information regarding the program version.

Overview of the menu bar (Standard menu)

File / New
Set up a new application (measurement application file).

File / Open
Call/open an application (measurement application memory).

File / Save
Save measurements and changes in the open application.

File / Save As
Save the open application under a new name.

File / Delete
Delete an application (File).

File / Properties
Opens the dialog window for setting application-specific parameters.

File / Print
Printout of the measurement data according to the settings under **Options/Options**, Tab *Printer Output*.

File / 1\Application Data\Test.app
List of the most recent opened files.

File / Exit
Closes the program MMS_CE.

Evaluation / Block Result
Call the block result for the selected block (block where the cursor is located).

Evaluation / Final Result
Calls the final result, evaluation according to range selection.

Evaluation / Measuring
Return from the evaluation display (block result, final result, histogram or sum frequency) to the measurement mode.

Evaluation / Delete all Measurements
Delete all measurement data of the open (= active) application. Only measurement data are deleted, the application-specific settings remain untouched.

Evaluation / Delete Actual Block
Delete the current block where the cursor is located.

Calibration / Normalization
Calls the normalization function. The procedure depends on the used measurement method and the connected probe, See the corresponding manuals beginning from page 2-23 and page 3-12 or 4-6

Calibration / Corrective calibration
Calls the corrective calibration function. The procedure depends on the used measurement method and

the connected probe, 🗐 See the corresponding manuals beginning from page 2-23 and page 3-12 or 4-6.

Calibration / ...

Depending on the used measurement method and the connected probe, additional functions (e.g., Calibration On Coating) for the adjustment of the measurement system to the specimen may be listed in the **Calibration** menu.

Calibration / Delete Corrective Calibration

Deletes the calibration factors of the open application. Deleting the corrective calibration causes the measurement data of the application to be deleted as well because no useful evaluation can be performed for measurement data with a different calibration.

Options / Free Display Mode

Enables and disables continuous measurement display. Measurement accept according to the setting in **File/Properties**, Tab *Trigger*. An enabled continuous mode is indicated in the pulldown menu by a check mark on the left.

Options / Secure Application

Securing and unsecuring applications. Securing refers to access to application-specific settings and the normalization and corrective calibration.

Options / Print Form Pattern

Defining print form templates for the block result, final result and for the data export, 🗐 5-7.

Options / Block Info

Defining information parameters for entering test information, 🗐 5-3. Test information is entered block by block. 🗐 5-4.

Options / Options

Parameter settings for the data transfer via USB, COM1 (RS232), 🗐 6-20, or for output to a printer. Enabling/disabling the audible signal at measurement accept.

Options / Supervisor

Various program settings; access is password-protected.

1.6 Abbreviations

In this manual the material names of specimens and coatings are abreviated. A short form or the chemical term will use:

Fe, iron, steel	Magnetizable material, usually ferrous
NF	Non-magnetizable, electrically conducting coatings (non-ferrous metal coatings), e.g., Aluminum, Zinc etc.
NC, Iso	Insulating materials, electrically non-conducting, non-magnetizable, e.g., Lacque, Epoxy
Al, Cu, Zn, Ms, ...	Aluminum, Copper, Zinc, Brass, ...

1.7 Technical Data

Instrument model	FISCHERSCOPE® MMS® PC2
Display/Screen	Large, high-resolution color display with touchscreen function; 170 mm x 130 mm / 6.7 " x 5.1 " (W x H) with 800 x 600 pixel
Keyboard/Operation	Operation via 8 membrane keys and functions buttons via touchscreen
Connections (standard)	1 x COM1 – RS232 interface 1 x LAN network connection 4 x USB connections for PC keyboard, PC mouse, printer 1 x USB connection for PC 1 x Multifunction connector with signal outputs for upper and lower limit violations, external start 1 x Jack socket for connecting e.g. a button for externally triggering the measurement capture 1 x Voltage supply One probe connector on each module board
Connectable printers	Printer with USB connection (2.0 compatible) which features one of the following printer language emulations: PCL, ESC/P
Hardware concept	Housing with 8 slots for module boards with different test methods
Dimensions (W x H x D)	360 mm x 170 mm x 270 mm / 14.2 " x 6.7 " x 10.6 "
Weight	fully equipped ca. 5 kg / 11 lb
Admissible ambient temperature range during operation	+10 °C … +40 °C / +50 °F … +104 °F
Admissible storage temperature	+5 °C … +60 °C / +41 °F … +140 °F
Admissible relative humidity	30 %RH. … 90 %RH, non condensing
Power supply	via AC line adapter Input: 100 … 240 V~, 50 … 60 Hz, max. 1 A; Output: 12V=, 1.5 A
Power consumption	AC line adapter max. 18 W
Operating system	Windows® CE
Measurement quantities	Coating thickness, electrical conductivity, ferrite content, temperature
Measurement test methods	• Magnetic test method (DIN EN ISO 2178, ASTM D7091) • Magnetic inductive test method (DIN EN ISO 2178, ASTM D7091) • Amplitude sensitive Eddy current test method (DIN EN ISO 2360, ASTM D7091) • Phase sensitive Eddy current test method (DIN EN ISO 21968) • Micro-Resistance test method (DIN EN 14571) • Beta-Backscatter test method (DIN EN ISO 3543, ASTM B567a)
Languages	Software available in European and Asian languages: German, English, French, Italian, Spanish, Czech, Turkish, Chinese and Japan
Measurement accept	• Automatic after probe touchdown • Through external start • In continuous running mode at the push of a button • Clocked in selected time intervals either after probe touchdown or after external start

Automated measuring	• Multi-channel measuring: Measurements of up to 8 Probes may be displayed and stored in one application. • Connected support stand V12MOT controlled by the FISCHERSCOPE MMS PC2 • PLC integration
Data export	• Online or offline of the measurement via the RS232 and USB interface • Export of result print forms as text files, ASCII files for importing to Excel spreadsheets, in Q-DAS or HTML format
Evaluation	Statistical evaluation of test series with mean value, standard deviation, coefficient of variation, maximum and minimum value, number of measurements, individual and block statistics, calculation of the process capability factors. Cp and Cpk; histogram, sum frequency chart with parameters of the distribution shape, FDD, evaluation from groups of blocks, filtered according to block designations.
Protocol	• Print form design with customer-specific information • The instrument can store any desired number of print forms
Measurement storage	The instrument stores measurements in application files. The following is also saved in these files: All settings, information on the measurement blocks, date, time and calibration data. • Default mode: measurements are saved in successive blocks in the application. Automatic block formation after a specified number n of individual measurements. Automatic calculation of the mean value • Matrix mode: measurements are stored in blocks which are set up in matrix form in the application. Block change in any desired block manually or automatically in a specified order
Data storage	• Internal memory of the instrument with 256 MB storage space • External USB stick • Company network
Measurement range, Trueness and Repeatability precision	Depends on the connected probe. You will find the details in the corresponding probe data sheet.

2 Coating Thickness Measurements - Using Electromagnetic Test Methods

2.1 The Path to Making Measurements

1. Connect the instrument to the line voltage (100 ... 240 VAC, 50 ... 60 Hz) (instrument connector: "+12V/1.2A"), 1-4.

The A/C line voltage must agree with the A/C line voltage rating on the serial number plate of the AC power supply!

2. Connect the probe to the suitable module socket.
3. Switch the instrument on: Press the orange **On/Off** key on the front of the instrument.
4. Set up the memory area (file) for the measurement application in the instrument (Setting up an application), 2-2. / Calling an application (file), 2-20.
5. Take influencing variables into account by adjusting the measuring system (instrument and probe) to the specimen (Corrective calibration), 2-9 and supplements listed in the following table.

Module in the MMS® PC2	Title	Page
PERMASCOPE®	Influencing Variables for Measurements with the PERMASCOPE® Module	2-23
SIGMASCOPE®/PHASCOPE®1	Influencing Variables for Measurements with the SIGMASCOPE®/PHASCOPE®1 Module	2-37
SIGMASCOPE®/PHASCOPE®2	Influencing Variables for Measurements with the SIGMASCOPE®/PHASCOPE®2 Module	2-57
PHASCOPE®/DUPLEX	Influencing Variables for Measurements with the PHASCOPE®/DUPLEX Module	2-84
NICKELSCOPE®	Influencing Variables for Measurements with the NICKELSCOPE® Module	2-115
SR-SCOPE®	Influencing Variables for Measurements with the SR-SCOPE® Module	2-105

6. Perform the measurment(s), 2-11
7. Store the application (file) in the instrument, 2-21.
8. View/print the evaluation (characteristic quantities, graphical display), 2-17/2-18.

2.2 Setting Up a New Application (File)

A file - the so-called application must be defined before making measurements with the FISCHERSCOPE® MMS® PC2. An application contains all data relevant for a measurement application. A measurement application is not only characterized by the material properties and the geometric shape of the specimen but also by probe type (measurement method, serial number of the probe). A new measurement application is present if one of these quantities changes and a new application must be set up.

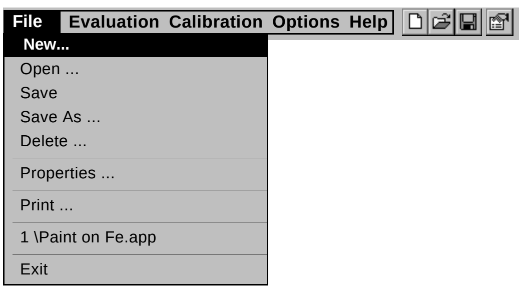
The material properties and the geometric shape of the specimen (captured by a normalization or corrective calibration), the probe type used and a few application-specific settings are pre-defined and the measurements are stored in an application file.

Required materials
A calibration is required when setting up the Application. Depending on the connected probe, the base material (= part without the coating material to be measured, taken from the production) or only the coating material (part consisting of the coating material alone, taken from the production) is required for the calibration. Appropriate for the probe in use, such a part must be available prior to setting up the Application. Potentially required calibration foils can be found as part of the probe's scope of delivery.

You will find further informationen on page 2-9 and in the sections of the individual modules up from page 2-23.

Procedure

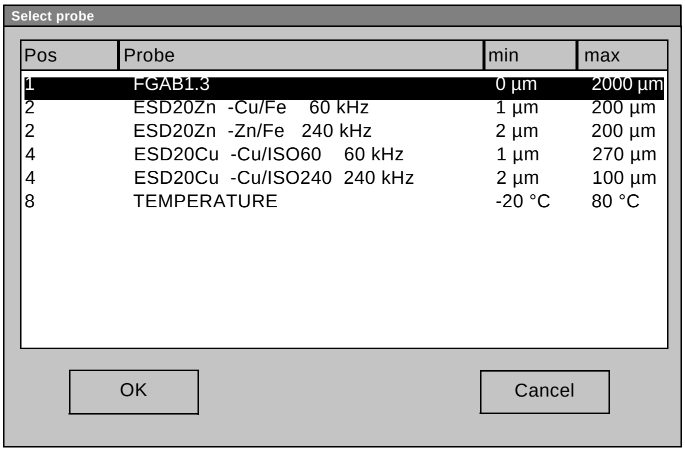
1. Calling the submenu "New ...":



Using the stylus, tap **File / New ...** on the display in succession.

The window *Select probe* appears.

2. Selecting the probe:



Pos	Plug-in position of the module, where the selected probe is connected.
Probe	Probe name, identical to the name on the probe connector or cable. For multifunctional probe models the combination of the desired coating-substrate materials or the probe frequencies are displayed additional. The probes ESD20Zn and ESD20Cu are shown for example. TEMPERATURE indicates the Temperature module, if mounted in the instrument.
min and max.	Measuring range of the probe

Window *Select probe*

The window shows the connected probes with their corresponding measuring ranges.

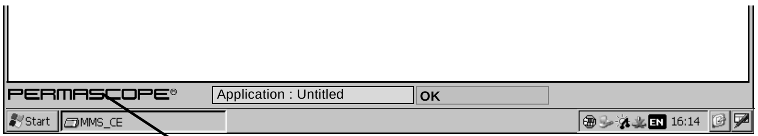
1. Select the probe (if indicated with the desired coating/substrate combination or measuring range). Example: Use the stylus to tap FGAB1.3 on the display. The selected probe name is highlighted in blue.

The displayed probe name is identical to the name on the probe connector or cable.

2. Tap the **OK** button with the stylus.

Go to the next step.

3. Calibration:



Used measurement test method

<u>Do not use</u> the supplied metal board (ISO/NF, NF/FE, Fe Base or Cu Saet.) as Base or coating material! It schould be used only for a function check of the instrument.

<u>Exception:</u>
The standards in the shipment of the probe models ESL080x and ERCU.
Calibration foils in the shipment of the probe models measuring the coating thickness using the magnetic induction and the amplitude sensitive eddy current test methods.

Adjusting instrument and the connected probe to a benchmark respectively to the specimen (material, form and surface property) and the ambient conditions.

Corresponding to the used probe and test method the adjustment procedure varied.

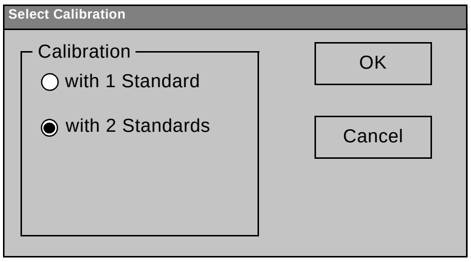
1. Perform the calibration by following the display instructions.

For further information, see page 2-9 and the sections of each module up from page 2-23.

Depending of the used probe the following windows may be appear on the display while calibration procedure:

Window *Select Calibration*

- Select the numbers of standards (calibration foils) used for the calibration. Our recommendation: „with 2 Standards"

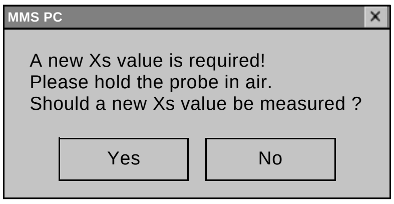


with 1 Standard
Enables an adjustment for a small coating thickness range around the standard value.

with 2 Standards
Enables an adjustment for the total measurement range of the probe or a range between two standard values.

Window *MMS PC*

- Hold the probe in the air and press the button **Yes**. At least 2" (5 cm) distance to the closest object.



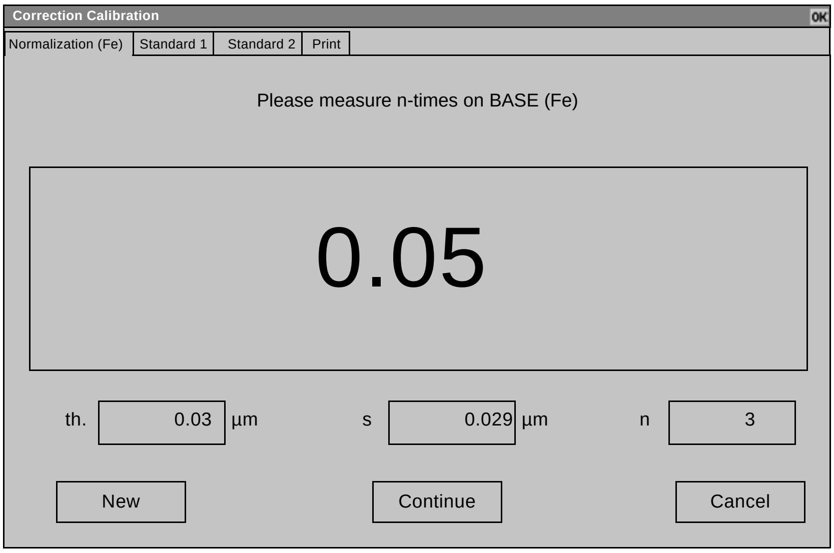
Window *Temperature* (no fig.)

- Select, in which manner the temperatur compensation should be performed.

Window *Normalization* **and** *Correction Calibration*

- The numbers of tabs differ corresponding to the connected probe, calibration type (Normalization or Correction Calibration) and numbers of the required standards.
- Substrate, also named Base: part from production (specimen) without the coating to be measured. Fe: magnetizable material NF: non-magnetizable metal
- Coating material, also named saturation or Cu ∞: only coating material. Ni: Nickel Zn: Zinc Cu: Copper

Example: Window *Correction Calibration*, tab *Normalization (Fe)* appears when using the measuring test method PERMASCOPE®



New	Discard the measurements. Perform a new measurement series on the base material.
Continue	Go to the next tab.
Fertig	(appears on the tab next to last) Finished the calibration procedure, change to the measuring mode
Canc el	Cancel the calibration procedure, change to the measuring mode
th.	Mean value of coating thickness
s	Standard deviation
n	Number of single readings

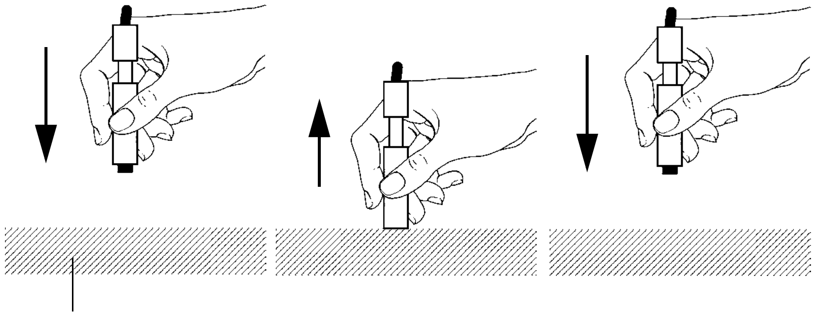
Measurements during the calibration and which is to be considered thereby.

Measure on base material

1. Perform 5 to 10 measurements on the base material.

2. Tap the **Continue** button with the stylus to go to the next step of the calibration routine.

Principle of a measurement demonstrated using the example of the FGAB1.3 probe



Base material or coating material depending to the used probe.

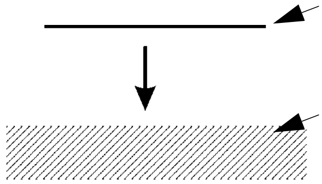
Example: Base material (Fe) = reference part make of magnetizable material, from the production, without the coating to be measured.

Measure on standards
(The following step ***1.*** is only relevant when using the measurement test method PERMASCOPE®)

1. Place the calibration foil (= standard) onto the base material.

ⓘ Only one foil must be on the reference part!

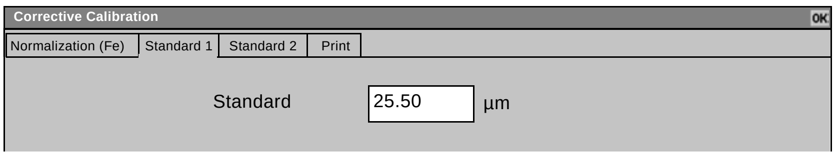
2. Enter the thickness that is specified on the calibration foil or coated reference part into the field „Standard": Douple-tap on the entry field (to the right of Standard). In the character bar at the bottom of the display, tap the numbers/characters in succession (Example: 1 2 . 5 for a foil thickness of 25.5 µm)



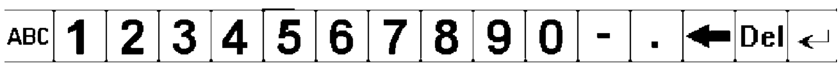
Standard = calibration foil only for test method PERMASCOPE®
The circle on the calibration foil must be on the marked measurement area of the uncoated reference part.

Base material (Fe)
Reference part without coating to be measured fron <u>own</u> production.

Window *Correction Calibration,* tab *Standard 1* respectively *2*



Standard Plastic foil or coated reference part with known coating thickness (corresponding to the used probe)

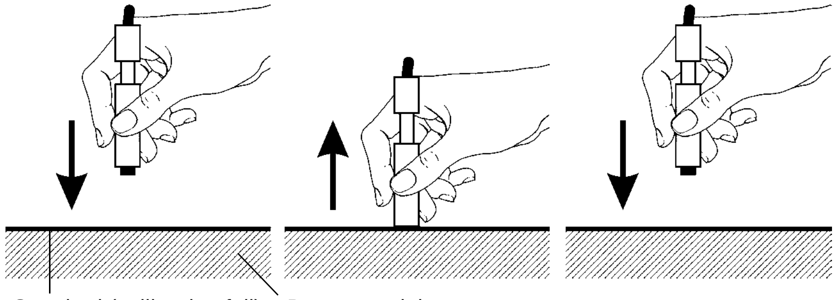


3. Perform 5 to 10 measurements on the standard (calibration foil or coated reference part).

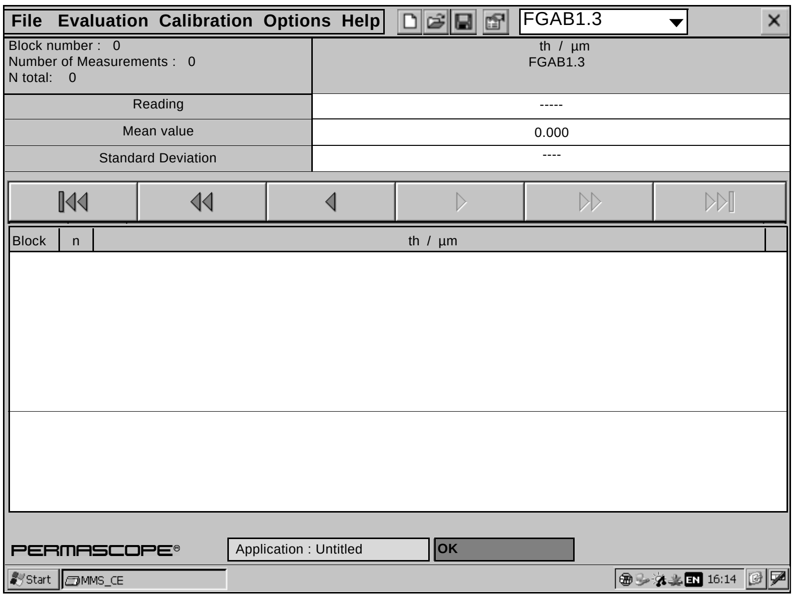
   If calibration foil use: for this purpose, place the probe inside the circle onto the foil.

4. Perform steps ***1.*** to ***3.*** with Standard 2 .

5. Tap the **Continue** button respectively the **Finish** button with the stylus.



If calibration foil use: Place probe inside the circle of the calibration foil.



Once the normalization is finished, the application is set up (application file) and measurements can be performed on the specimen.

Don’t forget to store the application file!
See next page.

Applications that are not saved will be lost when switching the instrument off! First save the newly set up application bevor starting with measurements.

If the trueness is not met when making measurements on customer reference parts (customer standards), a so-called corrective calibration should be performed to adjust the measurement system to the properties of the specimen. The specified accuracy values can be met only when doing so!

Take into account the influencing variable that could falsify the readings. Additional information can be found in Chapter “2.3 Influencing Variables“, page 2-9.

Perform a corrective calibration if necessary. Information, appropriate for the module and probe in use can be found in the Chapters "Measurements with Module ...”, beginning on page 2-23.

2.2.1 Saving a New Application

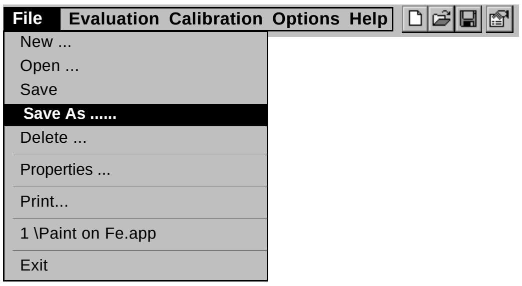
Measurements, calibrations and additional settings are saved in an application (= application file). To this end, the application must be given a name.

By giving the new application a name, it can be called again and measurements/settings can be stored under this application name (file name) at any time.

Applications that are not saved will be lost when switching the instrument off!
First save the newly set up application bevor starting with measurements.

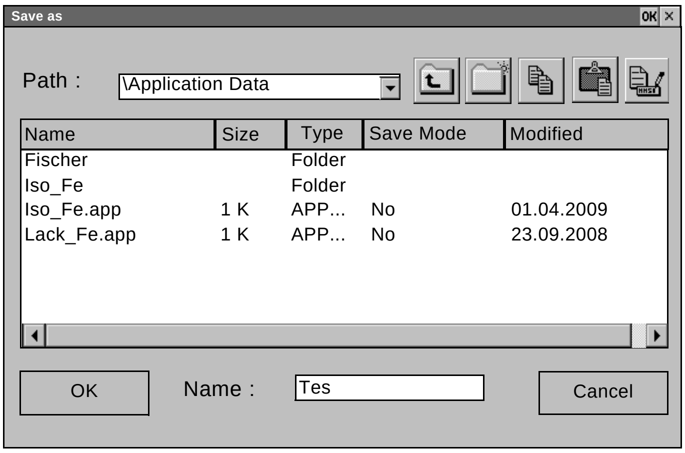
Procedure

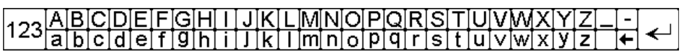
1. Calling the window *Save As...*:



Tap **File/Save As ...** on the display in succession using the stylus.

2. Assigning application names:





Window *Save As*

1. **Test** (sample name)
   Tap the letters in succession on the entry bar at the bottom of the display with the stylus.

   If necessary, switch the entry bar to characters/letters: tap the left control area **ABC** or **123**.

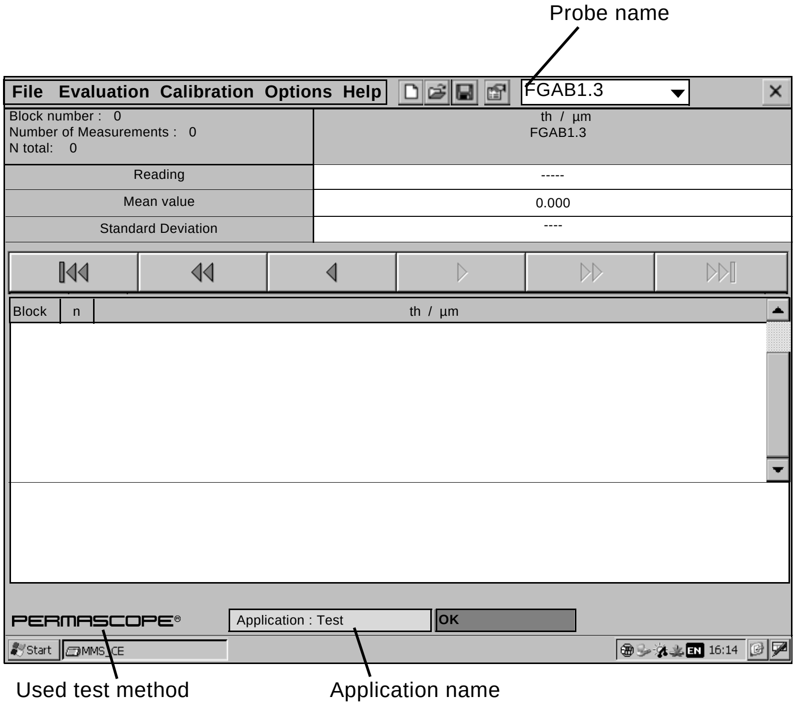
2. Tap the **OK** button with the stylus.

   The window *Save As* closes.

The newly set up application (= application file) has now been provided with a name (e.g., Test).

Addituional the calibration data and the probe characteristic data of the connected probe, with which this application was set up, are stored.

Now measurements can be made in the application "Test" (example).



Depending on the used module the test methods used for the coating thickness measurement are displayed as follow:

PERMASCOPE® - magnetic induction test method (DIN EN ISO 2178)
ISOSCOPE® - amplitude-sensitive eddy current test method (DIN EN ISO 2360)
DUALSCOPE® - either magnetic induction or amplitude-sensitive eddy current test method
FISCHERSCOPE® - multi-channel measurements (simultaneous measurements at several measurement spots
- magnetic induction and amplitude-sensitive eddy current test method simultaneous)
- Temperature measurement with the module TEMPERATURE

PHASCOPE® - phase-sensitive eddy current test method (DIN EN ISO 21968)
- magnetic induction, phase- and amplitude sensitive eddy current test method simultaneous

CU-SCOPE - phase-sensitive eddy current test method
NICKELSCOPE® - magnetic test method (DIN EN ISO 2178)
SR-SCOPE® - electrical resistance test method (DIN EN 14571)

2.3 Influencing Variables

The main variables influencing the coating thickness measurement using the electromagnetic test methods are:

- Physical properties of the specimen substrate material such as the electrical conductivity or the permeability.
- The geometric design of the specimen such as the thickness of the substrate material or a cylindrical shape.
- The position of the measurement spot on the specimen: distance to the edge, hole, offset or step.
- Surface roughness.
- Ambient and specimen temperature.

For correct measurements of the coating thickness, the instrument and the probe, together referred to as the measurement system, must “become familiar” with the specimen. This is done using a calibration. The influencing parameters are captured using one ore more reference parts and can then be compensated in future measurements. Which influencing parameters have an influence on the measurement depends on the measurement method (module) in use and the connected probe.

In calibration, we distinguish between normalization and corrective calibration. In most cases, the influencing variables mentioned above can be taken into account using a normalization (adjustment to a point of reference). Special sub-programs lead through the different types of calibration. Usually a calibration ist performed for the respective open application. The correction factors determined during the calibration have to stored in the open application.

Perform the corrective calibration carefully! It determines the accuracy for the subsequent measurements. - Measurements can never be more accurate than the corrective calibration!

Normalization

The normalization is the simplest kind of calibration and is used for adapting the measurement system to a reference point. Measurements are made on a reference part that corresponds to the actual part to be measured in material and shape. Depending on the connected probe, this part consists only of the substrate material, i.e.; without the coating material to be measured, or only of the coating material. Care should be taken during the measurement to ensure that the measurement location on the reference part is approximately at the same position where it will be on the part to be measured (curvature, distance to edge, hole, offset and step).

Calling: Calibration/Normalization.
Procedure: described for each module and test method in the corresponding chapters from 2-23 to 2-115.

Corrective Calibration

If the trueness is not met when making measurements on customer reference parts (customer standards), a corrective calibration should be performed to adjust the measurement system to the properties of the specimen. The corrective calibration not only adjusts the system to the substrate material but also to 1 to 2 coating thickness values by using so-called calibration foils or standards.

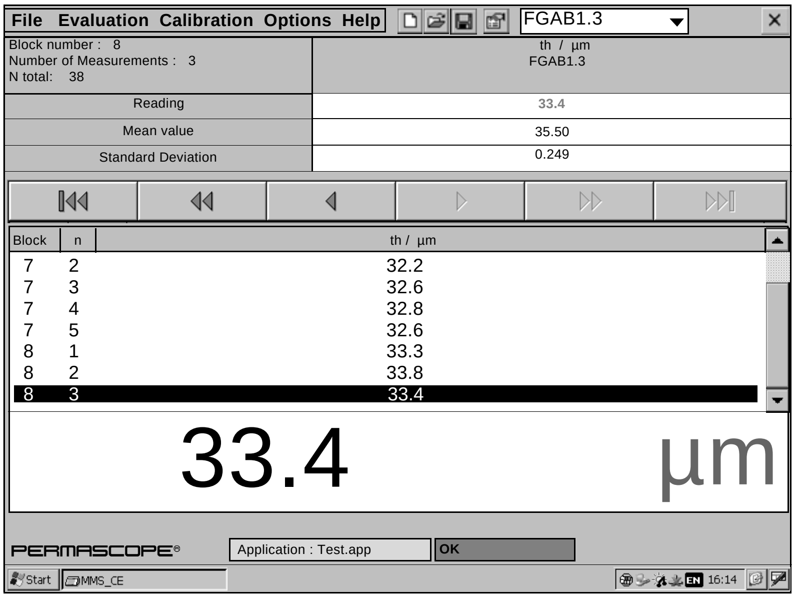
Calling: Calibration/Normalization.
Procedure: described for each module and test method in the corresponding chapters from 2-23 to 2-115.

Which variables influencing the coating thickness measurement depends on the test method of the used module and the used probe. The influencing variables and compensation are described for each module and test method in the chapters 2-23 to 2-115.

Module in the MMS® PC2	Page
PERMASCOPE®	2-23
SIGMASCOPE®/PHASCOPE®1	2-37
SIGMASCOPE®/PHASCOPE®2	2-57
PHASCOPE®/DUPLEX	2-83
SR-SCOPE®	2-105
NICKELSCOPE®	2-115

2.4 Making Measurements

2.4.1 Measurement Capture



Measuring mode Numeric Display: The reading with the unit of measurement is displayed. Example for an application setting up with the probe FGAB1.3 (module PERMASCOPE®).

- The instrument can make measurements only in the measurement mode.
- The measurements are accepted after placing the probe on the specimen signaled by a beep.
- The measuring point must be free of dirt and grease. This avoid erroneous measurements.
- Always place the probe gently and perpendicular to the surface on the specimen. Wait for the beep. Before making the next measurement, lift the probe about 5 cm (1.9 inches) off the specimen.

Informations about the handling of the probes, see the following pages for example.

2.4.2 Handling of the probes

- Always hold the probe at its handle ring (Fig. next side).
- Always place the probe gently and perpendicular to the surface on the specimen.
- Push the handle ring to the specimen surface such that the handle ring rests on the specimen surface (Fig. next side).
- The default setting is automatic measurements accept signaled by a beep.
- Before making the next measurement, lift the probe about 5 cm (1.9 inches) off the specimen.
- Place and lift the probe speedy.

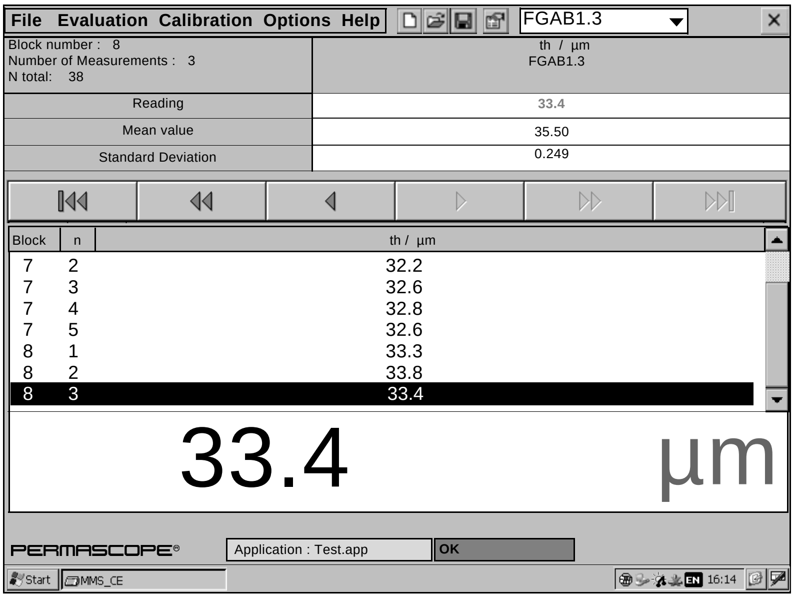
See the following pages for examples.
Informations for measurements with the probe type ERCU, see 2-11.
Informations for measurements with the probe type ESL080, see 2-71.

Avoid impacting the probe!

To avoid erroneous measurements, do not allow the probe to float above the specimen!

The instrument can make measurements only in the measurement mode!

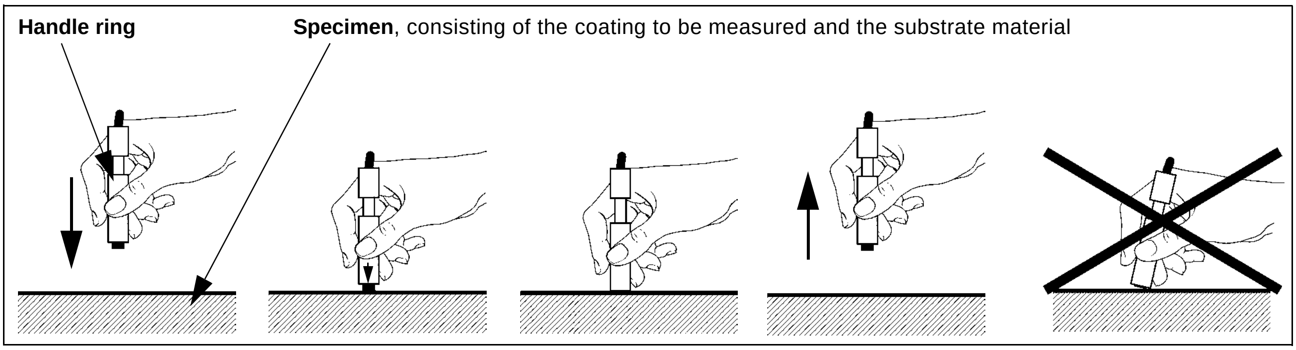
Do not bend the probe cable! It may lead to line breaks! The bending radius of the cable should be greater than 5 cm (1.9 inches)!



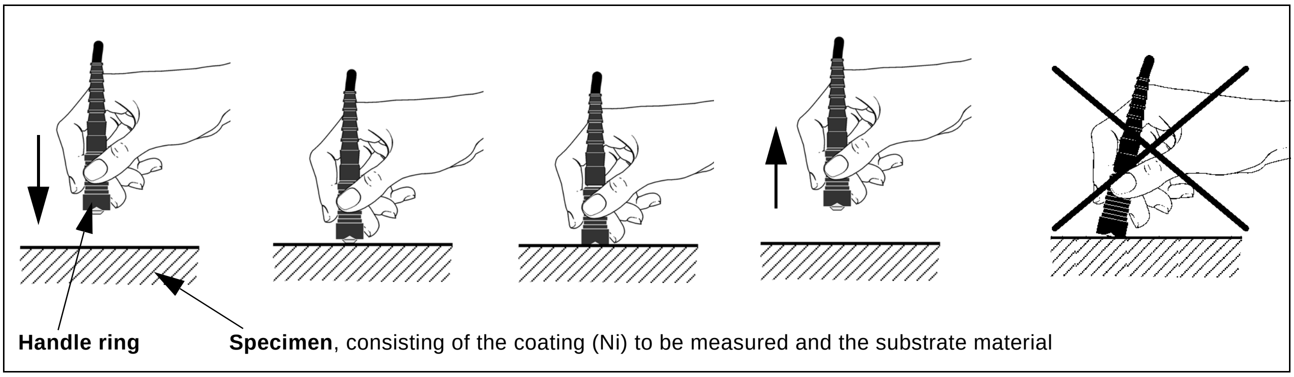
Left figure:
Measuring mode Numeric Display: The reading is displayed numerically with the unit of measurement. Example for an application setting up with the probe FGAB1.3 (module PERMASCOPE®)

2.4.3 Measurements on flat specimens...

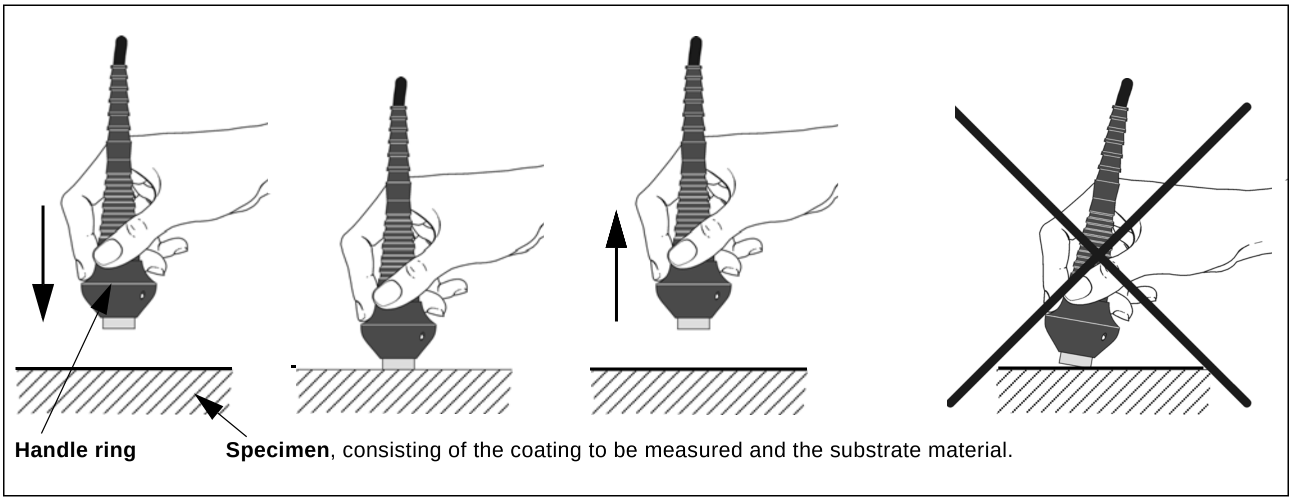
... demonstrated using the example of the FGAB 1.3 probe



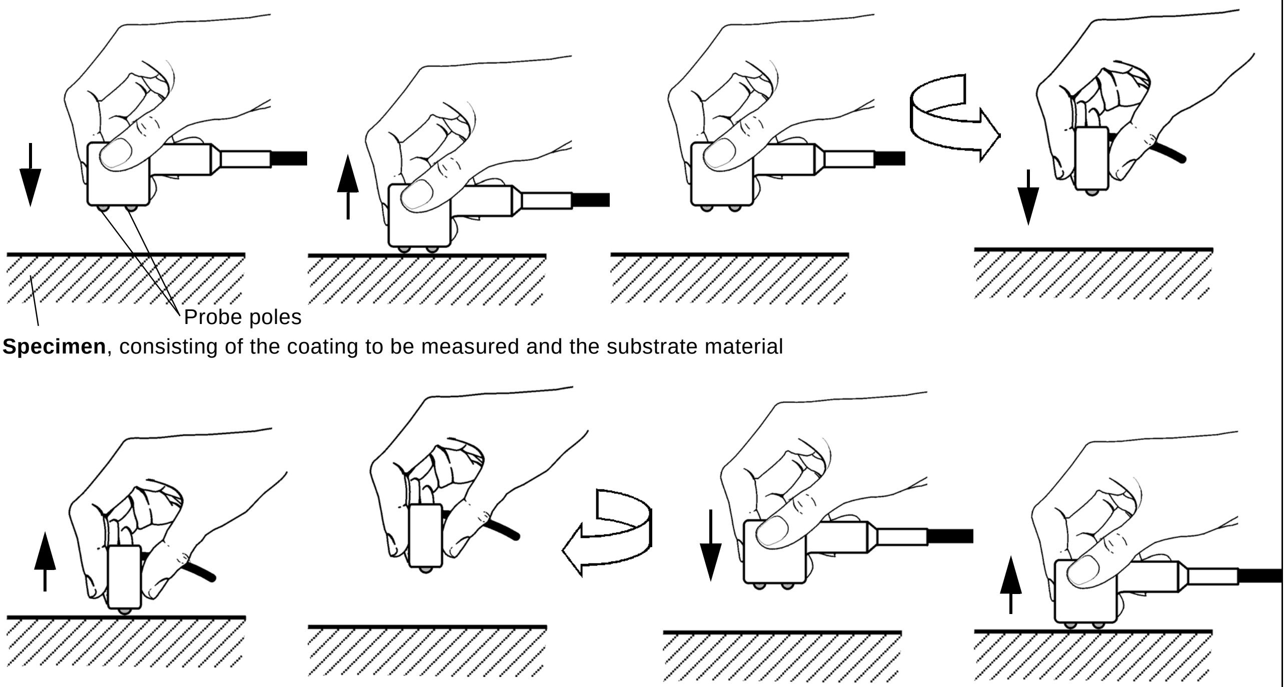
... demonstrated using the example of the ESD20Ni probe



... demonstrated using the example of the ESD30 probe



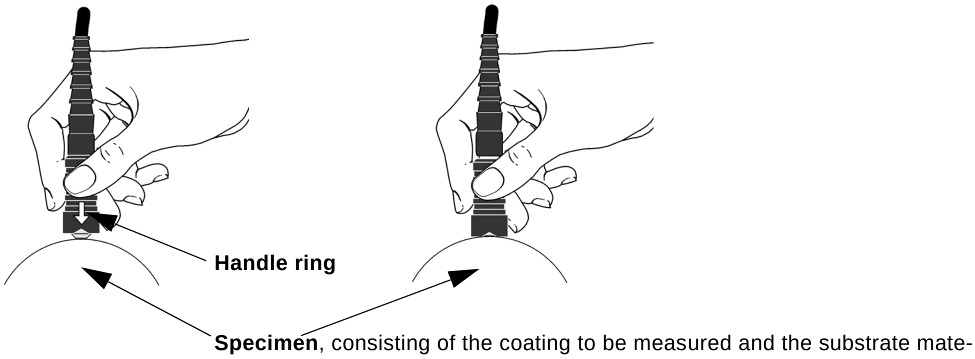
... demonstrated using the example of the two-pole probe EKB10



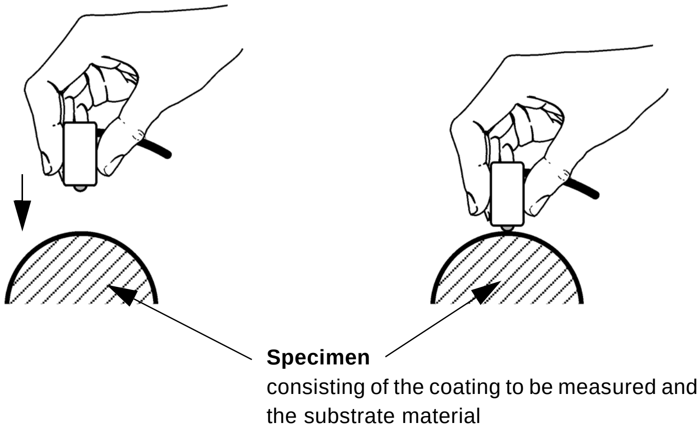
Rotate two-pole probes by 90° (horizontal to the surface) for each measurement placement on the specimen, to counter possible directional effects of the substrate. Check that both poles are in contact with the surface. If the probe is not spring-loaded, uniform contact pressure must be applied.

2.4.4 Measurement on curved specimens...

... demonstrated using the example of the ESD20Ni probe



... demonstrated using the example of the two-pole probe EKB10



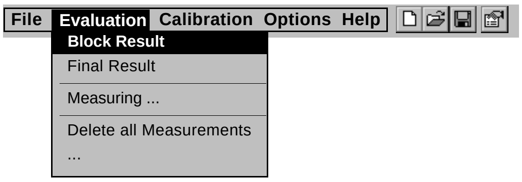
For cylindrical specimens, place the probe parallel to the longitudinal axis.

2.5 Evaluation - First Steps

The instrument saves the user from having to do the sometimes complicated and extensive mathematical computations for the statistical evaluation of the measurement data. The evaluation is performed for the respective open application. The measurement data can be displayed and printed in various presentation modes: listed as statistical characteristic data or graphical as a sum frequency chart or as a histogram.

An evaluation of the data measured since the last end of a block is carried out automatically in the background.

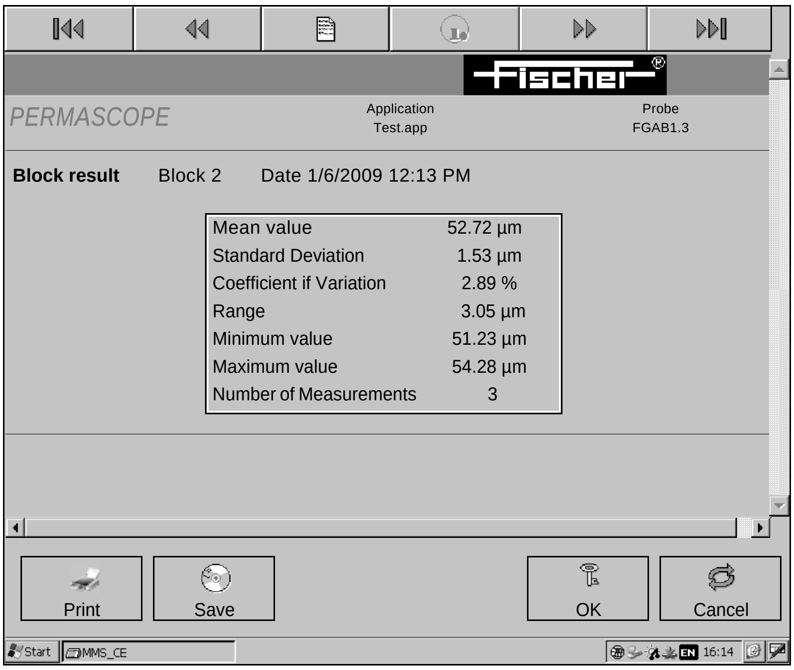
Statistical characteristic data



3. Calling the Block Result menu:

Tap **Evaluation / Block Result** on the display in succession using the stylus.

Block Result menu (example)



The *Block Result menu* appears on the display.

Print	Printing the block result
Save	Saving the displayed block result in the data formats txt, htm or pdf
⏮ ⏪ ⏩ ⏭:	Scrolling through the blocks.
:	Displays the single readings of the block.
:	No block information available.
:	Shows information of the displayed block.

4. Returning to the measurement mode:

Button **OK**: returning to the measuring mode with closing the block.

or

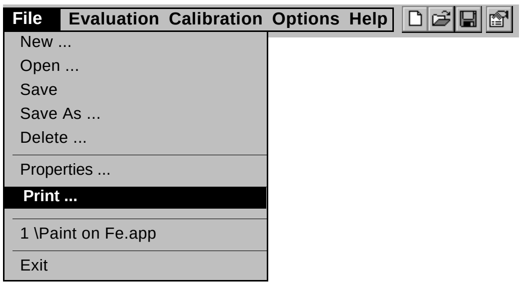
Button **Cancel**: returning to the measuring mode without closing the block.

2.6 Printing

The displayed measurement data or the displayed evaluation can be printed from the Print menu. The printer connected to the MMS® PC2 (USB port) must be switched on. Connecting a printer see chapter "Printing via USB Port", 6-4.

Procedure

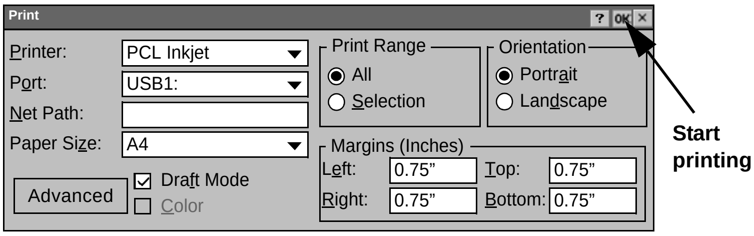
1. Calling the Print menu:



- Measuring mode: Tap **File / Print...** on the display in succession using the stylus.
- Evaluation menu: tap on the button Print using the stylus.

The window *Print* opens.

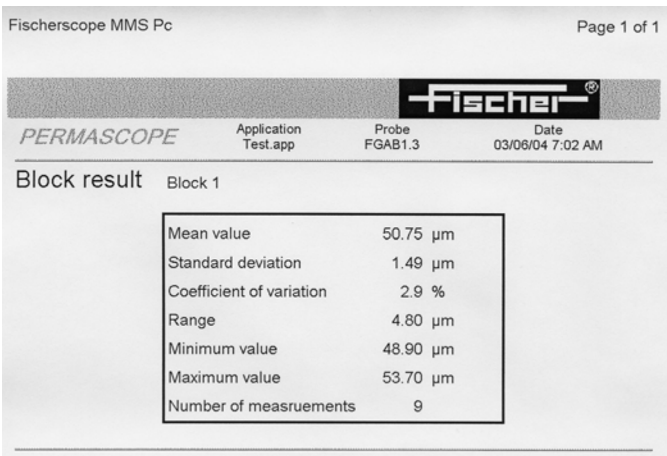
2. Set the print parameters in the window *Print*:



Select the connected printer (type) and the paper format to be used.

Printer:	Use the table at the end of this chapter to select the proper printer driver.
Port:	Selection of the used port. USB1: when the printer is connected to one of the 4 USB ports.

3. Start printing


Fischerscope MMS Pc Page 1 of 1

Fischer

PERMASCOPE Application Test.app Probe FGAB1.3 Date 03/06/04 7:02 AM

Block result Block 1

Mean value	50.75	µm
Standard deviation	1.49	µm
Coefficient of variation	2.9	%
Range	4.80	µm
Minimum value	48.90	µm
Maximum value	53.70	µm
Number of measruements	9	

Printout of the block result of the application 'Test' (example).

Tap the **OK** button in the upper right corner of the window *Print* with the stylus.

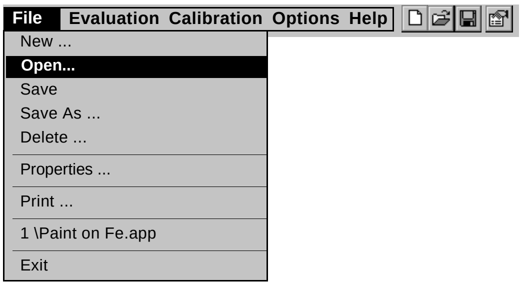
Printer Selection Table

Selectable printer driver (parameter "Printer")	Printing method and printer type
EPSON InkJet	all EPSON Inkjet printer
ESCP	all EPSON and other printer with ESC/P printer language emulation
generic Stylus C	EPSON printer series „Stylus C“
generic Stylus Color	EPSON printer series „Stylus Color“
generic Stylus Photo	EPSON printer series „Stylus Photo“
generic Stylus Photo R	EPSON printer series „Stylus Photo R“
PCL Inkjet	all inkjet printer from HP and other manufacturer, which dispose of PCL printer language emulation.
PCL Laser	all Laser printer, which dispose of PCL printer language emulation.
Kyosha Kyoline	Thermal printer of Kyosha, printer FPT 100, distributed from Fischer

2.7 Calling an Application (File)

Procedure

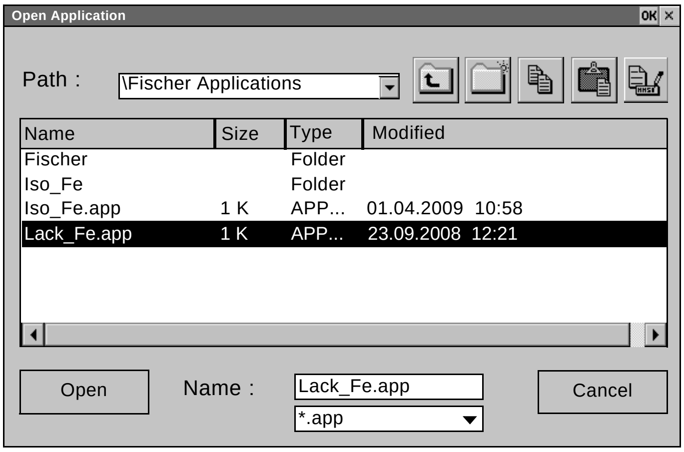
1. Calling the submenu "Open ...":



1. Tap **File / Open ...** on the display in succession using the stylus.

The window *Open Application* appears.

2. Select the desired application file.



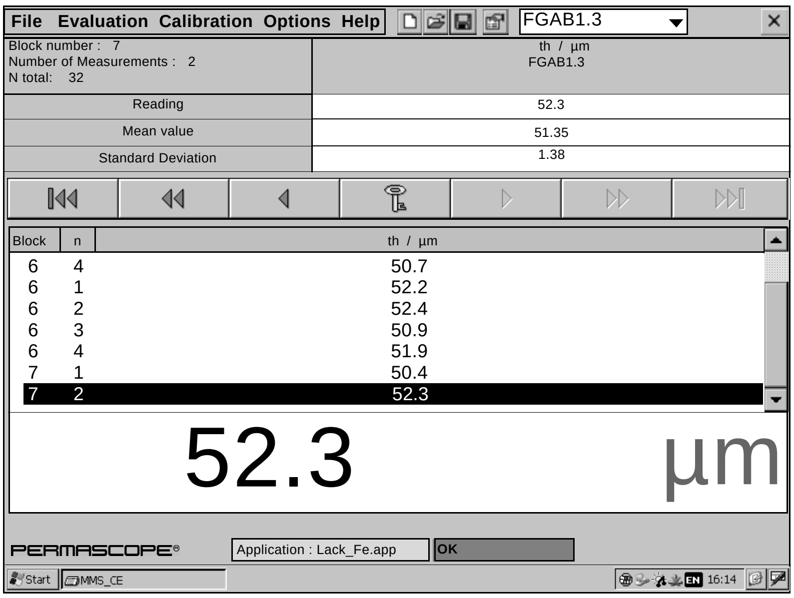
The selected application (file) are color highlighted (example).

Window *Open Application*

If necessary select the required directory. Therefore, tap the  button with the stylus to open the directory list. Select the desired directory. Tap the **Open** button with the stylus.

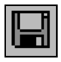
1. Tap the **Open** button with the stylus.

The desired application appears in the display.



Example for an application set up with the probe FGAB1.3 (module PERMASCOPE®).

2.8 Saving an Application File

Tap the  button in the application-related toolbar at the top of the display with the stylus.

2.9 Measurements with the PERMASCOPE® Module

The module PERMASCOPE® includes the magnetic induction method and the amplitude sensitive eddy current method. This allows for coating thickness measurements on both magnetizable and electrically conducting metals.

2.9.1 Influensing Variables Taken into Consideration

For correct measurements of the coating thickness, the instrument and the probe, together referred to as the measurement system, must “become familiar” with the specimen (part). This is done using a calibration. The influencing parameters are captured using a reference part and can then be compensated in future measurements. The calibration is preformed for the respective open Application. The correction factors determined in this step must be stored in the open Application (measuring application file).

Main variables influencing the coating thickness measurement for measurments with the PERMASCOPE® module (magnetic induction and eddy current test method):

- Physical properties of the specimen substrate material such as the electrical conductivity or the permeability.
- The geometric design of the specimen such as the thickness of the substrate material or a cylindrical shape.
- The position of the measurement spot on the specimen: distance to the edge, hole, offset or step.
- Surface roughness.

In calibration, we distinguish between normalization and corrective calibration.

Normalization

The normalization is the simplest kind of calibration and is used for adapting the measurement system to a reference point. For the measuring method of the module PERMASCOPE®, these are the base materials (magnetizable or non-magnetizable and electrically conducting). Measurements are made on a reference part that corresponds in material and shape to the actual part to be measured. It consists only of the base material, i.e., without the coating material to be measured. Care should be taken during the calibration to ensure that the measurement location on the reference part is approximately at the same position where it will be on the part to be measured (curvature, distance to edge, hole, offset and step).

Corrective Calibration

The corrective calibration adjust the measurement system to the properties of the specimen. The corrective calibration not only adjusts the system to the substrate material but also to 1 to 2 coating thickness values by using so-called calibration foils or standards.

If the trueness is not met when making measurements on customer reference parts (customer standards), a corrective calibration should be performed.

In general, the material properties (permeability) of the specimen will differ significantly from those taken into account in the factory pre-calibration. **It is, therefore, essential to perform the normalization or corrective calibration, respectively, using uncoated reference parts (specimens) from your own production!**

2.9.2 Normalization

Instrument and probe must be adapted to the base material at regular intervals when using the PERMASCOPE® module.

When necessary:

When the readings during a test measurement on a reference part are no longer acceptable. Test measurements should be carried out for a measuring application when it has not been used for a while.

Required Material:

BASE: Uncoated reference part (specimen) from the customer's **own** production. Specimen **without the coating to be measured**.

For creating a Base, take a specimen from the production and remove the coating (e.g. grind off, the surface should be clean or polished). Geometries and material properties of the uncoated reference part must correspond to those of the actual specimen. Mark the measurement area on the uncoated reference part at the location where it will be on the actual specimen (same edge distance, curvature). Now, the specimen becomes the Base.

Depending on the measurement method (displayed at the bottom left edge of the display), reference parts are required made of the following materials are required:

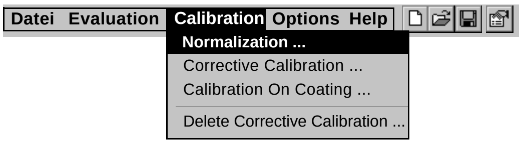
- PERMASCOPE®: Utilizes the magnetic induction measuring method
  BASE = ferromagnetic, reference part without the coating to be measred from customer's own production.
- ISOSCOPE®: Utilizes the eddy current measuring method
  BASE = non-magnetic, reference part without the coating to be measured from customer's own production.
- DUALSCOPE®: Utilizes the magnetic induction or the eddy current measuring method.
  Reference parts are required as described under PERMASCOPE® and ISOSCOPE®.
  When setting up an application with a dual probe, only one measurement method is initially taken into account during the calibration. If both measurement methods are permitted, then a calibration for the second measurement method must be performed later as well.
  🗐 Please pay attention to chapter Notes and Settings for the DUAL probes, page 2-31.
- FSCHERSCOPE®: Utilizes the magnetic induction and the eddy current measuring method.
  An adaptation must be carried out for each of the two measurement methods.
  2 Reference parts are required as described under PERMASCOPE® and ISOSCOPE®.
  🗐 Please pay attention to chapter Notes and Settings for the Duplex probes, page 2-33.

Do not use the supplied metal board (NF/FE or ISO/NF) for base!!!
As a rule, the material properties will not correspond to the uncoated specimen from customer‘s own production! Use it only for instrument check!

Please note:
The substrate material from different batches will have different permeabilities or electrical conductivities. This means that the measurement system must be adapted to the changed material properties before making measurements on specimens from the new batch. For this purpose, the Base must be set up from the new batch! Perform a new normalization with this new Base.

Procedure:

1. Calling the normalization function:

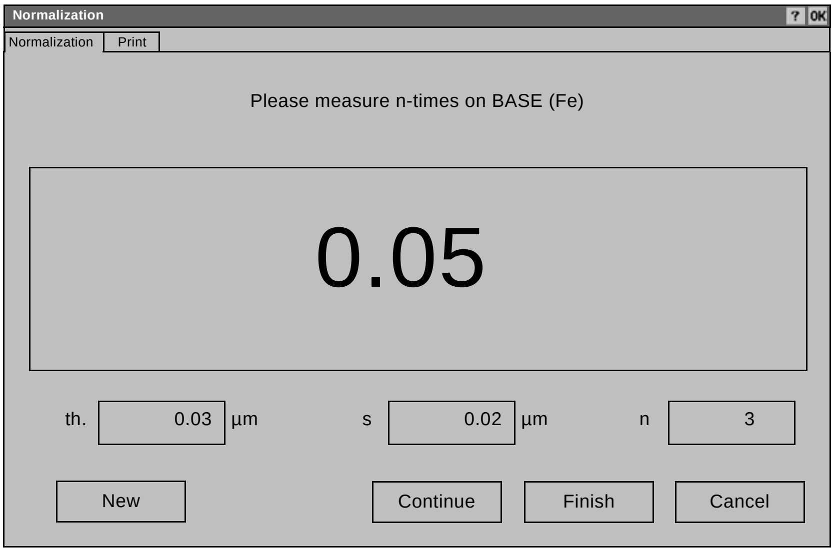


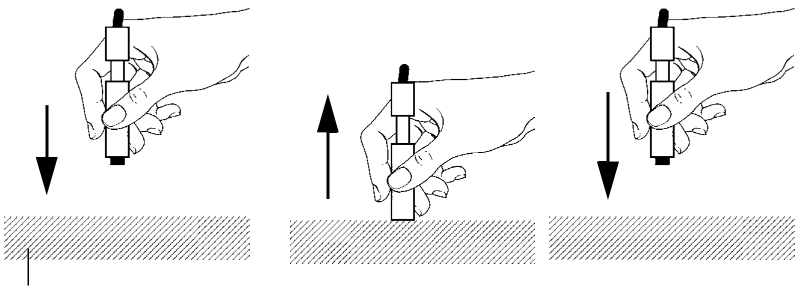
Open window *Normalization*

Tap **Calibration / Normalization ...** on the display in succession using the stylus.

2. Measurement on substrate material:

Window *Normalization*





Substrate material (Base), specimen without coating to be measured from customer's own production.

Place the probe on the marked measurement area.

Perform 5 to 10 measurements on the uncoated reference part (= BASE, specimen without the coating).
Place the probe on the marked measurement area.

3. Finishing the normalization:

Tap the **Finish** button with the stylus.

Close window *Normalization*

4. Saving the parameters of the normalization:

Tap the button with the stylus.

Saving Normalization in the current application

Now measurements can be made

2.9.3 Corrective Calibration

The corrective calibration adjust the measurement system to the properties of the specimen. The corrective calibration not only adjusts the system to the substrate material (normalization) but also to 1 to 2 coating thickness values by using so-called calibration foils or standards. Instead of the foils, coated reference parts with known coating thickness values (measured with a different test method, e.g., x-ray flourescence method) can also used as standards. Materials and shape of the calibration standards must correspond to those of the specimen to be measured. The same applies to the position of the measured areas. The position of the measurement spot on the calibration standard must correspond to that on the subsequent test specimens, i.e., the test parts from the production (same distance to edge/borehole, same curvature radius, etc.).

The corrective calibration must be performed using at least one calibration standard. We recommended using 2 calibration foils supplied with the probe for the corrective calibration. The corrective calibration applies only to the open application (file).

A corrective calibration with the calibration foils supplied with the probe provides the best measurement accuracy for the entire range. If calibration foils with other thickness values are used for the corrective calibration, then the specified truenesses of the probe data sheet apply only in the coating thickness range that is defined by the thicknesses of the used calibration foils. This means that an accurate measurement with the specified trueness is possible only in this coating thickness range. A new corrective calibration (possibly in a new and different application) must be performed for measurements outside of this coating thickness range. For example, the coating thicknesses of the calibration standards should be about 6 and 15 µm if the Zn thickness range to be measured is between 6 and 15 µm. If the Zn thickness range to be measured is expanded to about 25 µm, then a new corrective calibration must be performed using calibration standards with suitable thicknesses (for example, 6 and 25 µm).

To improve the accuracy in a certain thickness range, a foil should be used with a thickness that corresponds to the expected coating thickness of the specimen. However, the accuracy outside this particular thickness range is typically worse than with the corrective calibration using the supplied calibration foils.

A corrective calibration should always be performed under conditions that are comparable to those of the specimen!
Same substrate material for the calibration standard and for the specimen, same curvature, etc.!

Perform the corrective calibration carefully! It determines the accuracy for the subsequent measurements. - Measurements can never be more accurate than the corrective calibration!

When necessary:

If the trueness is not met when making measurements on customer reference parts (e.g. customer standards or reference parts).

When normalization is not sufficient to compensate for the influence.

Required materials:

BASE:

Uncoated reference part (specimen) from the customer's **own** production. Specimen **without the coating to be measured**.

For creating a Base, take a specimen from the production and remove the coating (e.g. grind off, the surface should be clean or polished). Geometries and material properties of the uncoated reference part must correspond to those of the actual specimen. Mark the measurement area on the uncoated reference part at the location where it will be on the actual specimen (same edge distance, curvature). Now, the specimen becomes the Base.

Depending on the measurement method (displayed at the bottom left edge of the display), reference parts made of the following materials are required:

- PERMASCOPE®: Utilizes the magnetic induction measuring method
  BASE = ferromagnetic, reference part without the coating to be measred from customer's own production.
- ISOSCOPE®: Utilizes the eddy current measuring method
  BASE = non-magnetic, reference part without the coating to be measured from customer's own production.
- DUALSCOPE®: Utilizes the magnetic induction or the eddy current measuring method.
  Reference parts are required as described under PERMASCOPE® and ISOSCOPE®.
  When setting up an application with a dual probe, only one measurement method is initially taken into account during the calibration. If both measurement methods are permitted, then a calibration for the second measurement method must be performed later as well.
  Please pay attention to chapter Notes and Settings for the DUAL probes, page 2-31.
- FISCHERSCOPE®: Utilizes the magnetic induction and the eddy current measuring method.
  A corrective calibration must be carried out for each of the two measurement methods. 2 Reference parts are required as described under PERMASCOPE® and ISOSCOPE®.
  Please pay attention to chapter Notes and Settings for the Duplex probes, page 2-33.

Do not use the supplied metal board (NF/FE or ISO/NF) for base!!! As a rule, the material properties will not correspond to those of the uncoated specimen! Use it only for instrument check!

Please note:
The substrate material from different batches will have different permeabilities or electrical conductivities. This means that the measurement system must be adapted to the changed material properties before making measurements on specimens from the new batch. For this purpose, the Base must be set up from the new batch!

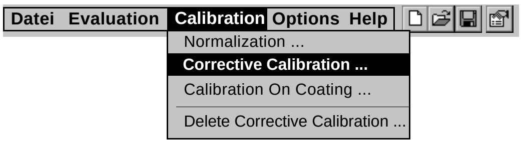
Standards:

Calibration foil(s) supplied with the probe for the entire range or a calibration foil with a thickness that corresponds to the coating thickness to be measured. If the coating thickness to be measured is, for example, at about 15 µm, foil thicknesses of about 9 and 24 µm should be used for the corrective calibration. On the foil, the measurement area is marked with a circle.

Please contact your authorized distributor or Helmut Fischer GmbH directly for calibration foils with suitable thicknesses. www.helmut-fischer.com

Procedure:

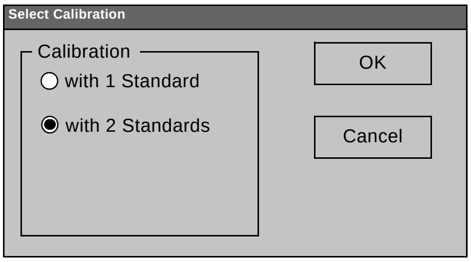
1. Calling the corrective calibration function:



Open Window *Corrective Calibration*

Tap **Calibration / Corrective Calibration ...** on the display in succession using the stylus.

2. Select the number of calibration foils (Standards) used for the corrective calibration:



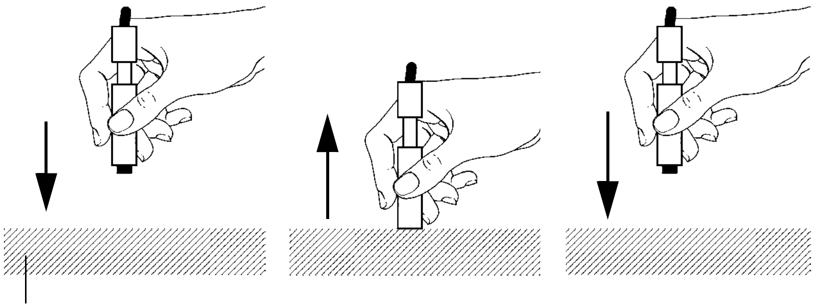
Window *Select Calibration*

1. :Tap "**with 2 Standards**" to get the best measurement accuracy for the desired probe range.

2. Tap **OK** button with the stylus to confirm the selection.

The window *Correction Calibration* opens.

3. Measurement on uncoated refernce part (substrate material adjustment):

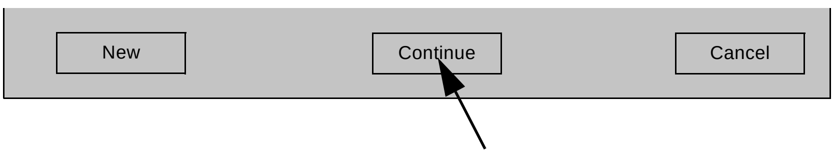


Substrate material (Base), specimen without coating to be measured, reference part from customer's own production.

Place the probe on the marked measurement area.

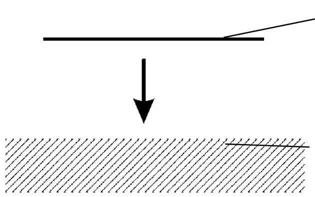
Window *Correction Calibration* **Tab** *Normalization*

1. Perform 5 to 10 measurements on the uncoated reference part (= BASE, same substrate material as the specimen from the customer’s productions). Place the probe on the marked measurement area.



2. Tap the **Continue** button with the stylus.

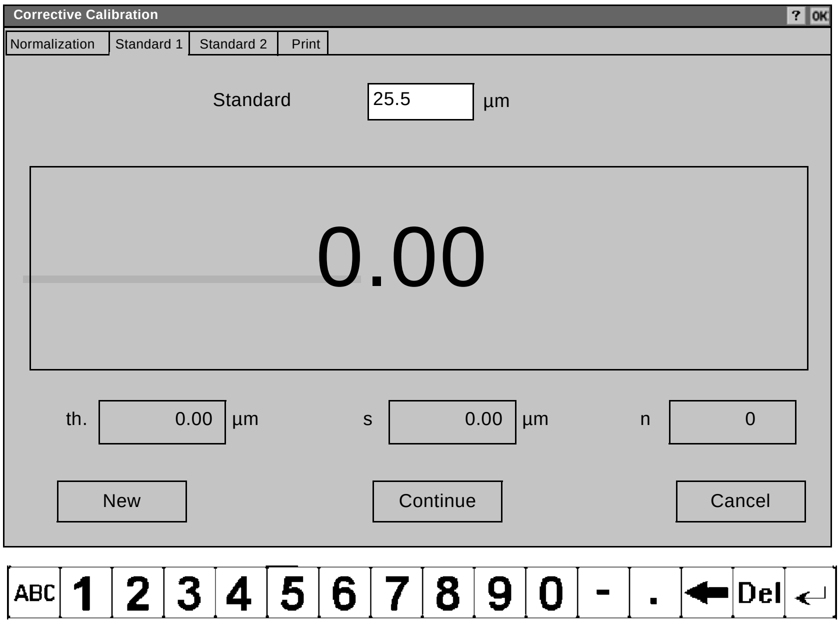
4. Measurement on Standard 1(2) (calibration foil):

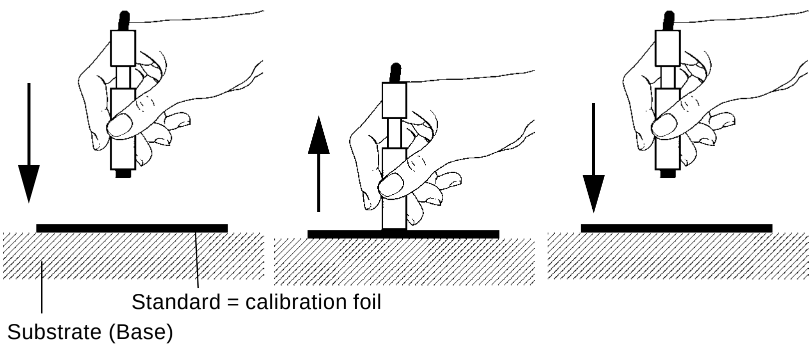


Standard

The circle on the calibration foil must be on the marked measurement area of the un-coated reference part.

Substrate material (Base), specimen without coating to be measred, reference part from customer's own production.





Place the probe inside the circle of the calibration foil.

Window
Correction Calibration
Tab *Standard 1 (2)*

1. Place the calibration foil with the defined thickness onto the substrate material (= BASE).

Only one foil at a time may be placed on the reference part! When using 2 standards (calibration foils): Remove calibration foil 1 for the second run and only then place calibration foil 2.

2. The displayed standard thickness does not correspond to the thickness of the foil that is placed on the substrate. In this case, enter the thickness that is specified on the calibration foil into the field "**Standard**": Double-tap on the entry field (to the right of Standard). In the entry bar at the bottom of the display, tap the numbers/ characters in succession (Example: 2 5 . 5 for a foil thickness of 25.5 µm).

3. Perform 5 to 10 measurements on the calibration foil (= Standard 1 resp. 2).

For this purpose, place the probe inside the circle onto the foil.

For the corrective calibration with only one calibration foil, or after the measurement on Standard 2 continue with step # ***6.***

4. Tap the **Continue** button with the stylus.

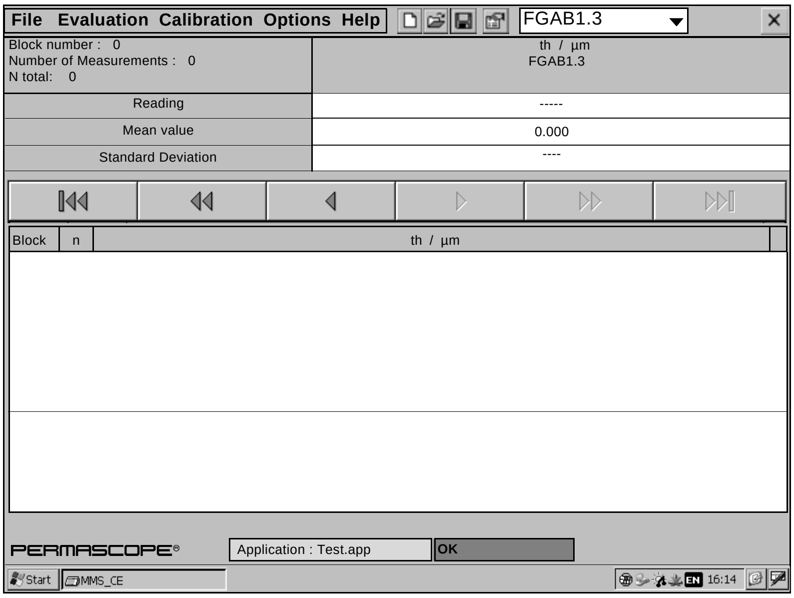
5. Perform steps 1. to 3. with the second calibration foil

(Standard 2). Then continue with step # ***6.***

6. Tap the **Finish** button with the stylus.

The window *Correction Calibration* closes.

5. Saving the correction factor of the corrective calibration in the current application:



Measuring mode Numeric Display;
example for an application setting up with the probe FGAB1.3

Saving the correction calibration

Tap the button with the stylus.

The corrective calibration is finished and has been stored in the open application. Thus, for this application, a new corrective calibration is not required before every measurement.

Now, measurements can be made in the current application.

2.9.4 Dual Probes - Notes for Using and Setting

Dual probes work either according to the magnetic induction method or the amplitude-sensitive eddy current measurement method. The dual probe will use one of the two methods depending on the setting and the base material. Thus, it is possible to use this probe to measure non-magnetic coatings or electrically non-conducting coatings on steel or iron as well as electrically non-conducting non-metal coatings on non-ferromagnetic substrate materials (Al, Cu, ...).
User settings determine which measurement method(s) shall be available for all applications that are set up with the connected dual probe!
Examples for dual probes: FD10 or FD13.

Selection of the usable measuring methods

The selection of the dual mode is an instrument setting and applies to all Applications that have been set up with the connected dual probe!

Dual Method	Description	
only NF/Fe system	Utilizes only the magnetic induction measuring method	Selecting the suitable dual method is, for instance, the way to ensure that only the thickness of the coating of interest is determined when measuring on a multi-coating system.
only ISO/NF system	Utilizes only the eddy current measuring method.	
both systems	Default setting Both measuring methods can be used for measuring.	The suitable test method is selected automatically when placing the probe on the measuring object (if a normalization has ben performed for both measuring methods). When setting up an Application with a dual probe, initially the Application is set up only for one of the two measuring methods, depending on the substrate material that has been used for the normalization. Iron or steel substrate for the magnetic induction measuring method. Non magnetic metal substrate (Al, Cu, Zn, ...) for the eddy current measuring method. With a subsequent normalization on the other substrate material, it will then be possible to take readings in an Application with both measuring methods.

Example multi-coating system Iso/NF/Fe (e.g. Lacquer/Zn/Fe)

Non-conductive coating (e.g. Lacquer)	Iso
Non-ferromagnetic metal coating (e.g. Zn)	NF
Ferromagnetic substrate (Fe)	Fe

Selecting the suitable dual method is, for instance, the way to ensure that only the thickness of the coating of interest is determined when measuring on a multi-coating system.
For example, the thickness of the non-ferromagnetic (NF) coating has to exceed a minimum thickness (for zinc approx. 70 µm (2.4 mils)) and the dual method only Iso/NF system has to be

selected to determine only the thickness of the non-conductive (Iso) coating of figure.
If only NF/Fe system is selected, the ferromagnetic substrate will be used to determine the thickness of the Iso and the NF metal coating.
If both systems is selected, depending on the thickness and electrical conductivity of the NF coating either only the thickness of the Iso coating (for relatively thick NF layers) or the thickness of the Iso coating and the NF metal coating (for relatively thin NF layers) will be determined.

Procedure for selecting the dual mode

! The selection of the dual mode is an instrument setting and applies to all Applications that have been set up with the connected dual probe!

1. **Calling theSupervisor menu: Extras / Supervisor...**

   Use the stylus to tap these menu commands in succession.

   Open Window *Supervisor*

2. **Entering the Supervisor code (password): 1 5 9**

   Use the stylus to tap the numbers in the charater bar at the bottom of the display in succession.

   Enter Supervisor code (password)

3. **Tab the** *Dual* **tab using the stylus.**

   Window *Supervisor*

4. **Selecting the desired mode using the stylus.**

   ○ = Parameter/Mode disabled.

   ◉ = Parameter/Mode enabled.

   Parameter selection

5. **Exiting the Supervisor menu:** tab **OK** button using the stylus.

   Auswahl speichern

2.9.5 Duplex Probes - Notes, Normalization, Corrective Calibration

Measurement probe for measuring duplex coatings (paint/zinc) on steel sheet (e. g., in appliance manufacturing) or steel constructions. The magnetic induction and the amplitude-sensitive eddy current measurement methods are used simultaneously during the measurement. The thicknesses of both coatings (paint, zinc) are shown next to each other on the display.
The total thickness of the paint/zinc coating on the ferrous substrate material and the paint thickness on the zinc coating are measured. The zinc thickness is then calculated from the two readings.
Example for Duplex probe: FDX10.

To observe when making DUPLEX measurements:

- Measurable zinc coatings: hot galvanized zinc coatings including diffusion coatings.
- Minimum required zinc coating thickness: 70 µm.
  Duplex coatings with smaller zinc coating thicknesses can no longer be measured with FDX type probes.
- Coatings made of zinc alloy (e.g., ZnFe, ZnNi) cannot be measured!

As a rule, the Fe sheets from different batches will have different permeabilities. This means that the measurement system must be adapted to the changed material properties before making measurements on a new batch. As a rule, a normalization should be sufficient if the zinc bath is not changed. If the zinc bath has changed as well, a corrective calibration should be performed. For this purpose, base, saturation and calibration standards must be set up from the new batch.

Required materials/standards (from own production):

- **Fe**: Uncoated ferromagnetic reference part (specimen) from the customer's **own** production. Specimen made of ferromagnetic material. - For the adaptation using the magnetic induction measurement method.
  For creating, take a specimen from the production and remove the coating (e.g. grind off, the surface should be clean or polished). Geometries and material properties of the uncoated reference part must correspond to those of the actual specimen. Mark the measurement area on the uncoated reference part at the location where it will be on the actual specimen (same edge distance, curvature). This part is now the uncoated reference part that can be used for the normalization and corrective calibration of a duplex measuring application.

Do not use the supplied metal board (NF/FE or ISO/NF) for base!!! As a rule, the material properties will not correspond to those of the uncoated specimen! Use it only for instrument check!

- **NF/Fe**: Zn coated parts **without** lacquer coating from the production with Fe substrate, Zn coating materials and geometry that correspond to those of the specimen. The thickness of the Zn coating material should be in the range of the coating thickness to be measured. - For the adaptation with the amplitude-sensitive eddy current measurement method.
  To this end, take a zinc-coated part without paint coating from the production. The minimum Zn coating thickness should be 70 µm. Mark the measurement area on the uncoated Zn/Fe part at the same location where it will be on the actual specimen (edge distance, curvature, etc.). This part is now the second required reference part that can be used for the normal-

ization and corrective calibration of a duplex measuring application.

Use the supplied Zn part “Zn Saet.” (602-663) for the normalization or corrective calibration only if there is no possibility to make your own Zn-coated reference part with a minimum 70 µm Zn coating thickness. In such a case a loss of measuring precision must be expected.

Calibration foils: Plastic foil of known thickness supplied with the probe. A circle on the foil marks the measurement spot.
Only necesary for corrective calibration.

Procedures

- Normalization with probe type FDX (e.g., FDX10), see page 2-35
- Corrective calibration with probe type FDX (e.g., FDX10), the principle measurements on base an Zn coating are described in Chapter 2.9.3, beginning from page 2-28. See necessarily the notes on the instruction leaflet delivered with the probe.
  Two kinds of calibration routines are selectable, depending on the availability of a ferromagnetic substrate material.

  NF/Fe and Iso/Zn/Fe: perform a corrective calibration using an uncoated ferromagnetic substrate material and a zinc reference part with ferromagnetic substrate material.

  Iso/Zn/Fe (without Fe): perform a corrective calibration using only a zinc reference part with ferromagnetic substrate material. An uncoated ferromagnetic substrate material is not available. Attend that in this case the specified accuracies of the probe data sheet do not observe.

  We recommend using the corrective calibration routines "NF/Fe" and "Iso/Zn/Fe" to adapt each of the two measurement methods. This provides the best measurement accuracy for the entire range.

Normalization with Probe Type FDX (e.g., FDX10)

Adjustment of instrument and probe to the Fe base material and the Zn coating material.

Required Materials: see section "Required materials/standards (from own production):", 2-33.

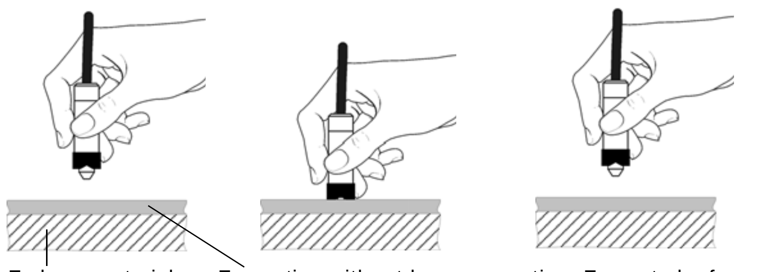
Procedure

1. Calling the normalization function:

Tap **Calibration / Normalization ...** on the display in succession using the stylus.

Call up Normalization function

2. Measurement on Zn coating (Zn/Fe):



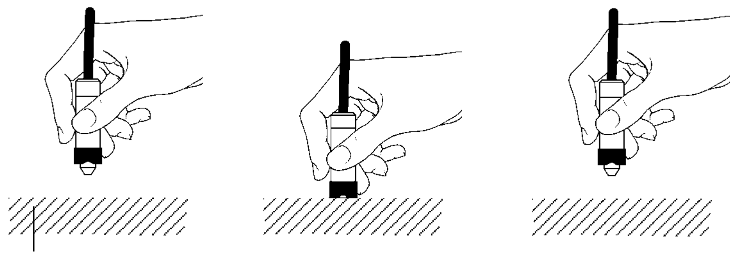
Fe base material Zn coating without laqucer coating. Zn coated refernce part (Zn/Fe) from own production.

Place probe on the marked measurement.

Window *Normalization,*
tap *Normalization Zn/Fe*

1. Perform 5 to 10 measurements on the Zn coated reference part (Zn/Fe). Place the probe on the marked measurement area.
2. Tap the **Continue** button with the stylus.

3. Measurement on uncoated Fe base material (Fe):



Fe base material without coatings. Uncoated reference part from own production.

Place probe on the marked measurement.

Window *Normalization*,
tap *Normalization Fe*

1. Perform 5 to 10 measurements on the uncoated reference part (Fe base material (Fe)). Place the probe on the marked measurement area.

4. Exiting Normalization: Tap the **Finish** button with the stylus.

Close Window *Normalization*

5. Saving the normalization in the current application:

Tap the button with the stylus.

Save Normalization

Perform measurements.

2.10 Measurements with the SIGMASCOPE®/PHASCOPE®1 Module

The module SIGMASCOPE®/PHASCOPE®1 includes the phase sensitive eddy current method. Well suited for coating thickness measurements on magnetic substrate materials as well as on electrically non-conducting materials.

2.10.1 Consider Influencing Variables

For correct measurements of the coating thickness, the instrument and the probe, together referred to as the measurement system, must “become familiar” with the specimen (part). This is done using a calibration. The influencing parameters are captured using a reference part and can then be compensated in future measurements. The calibration is preformed for the respective open Application. The correction factors determined in this step must be stored in the open Application (measuring application file).

Main variables influencing the coating thickness measurement for measurements with the SIGMASCOPE®/PHASCOPE®1 module (phase sensitive eddy current test method):

Coating/Base material	Influencing variables	Probe	Corrective Calibration Page
NF/Iso	● Electrical conductivity of the coating material (Cu).	ESD20 (Cu/Iso)	2-39
NF/Fe	● Electrical conductivity of the coating material (Cu, Zn). ● Magnetic permeability of the ferromagnetic base substrate material.	ESD20 Zn (Cu/Fe, Zn/Fe) ESD2.4 (Zn/Fe)	2-48
Ni/Fe	● Magnetic permeability of the electroplated Nickel coating and the ferromagnetic base substrate material.	ESD20 Ni (Ni/Fe)	2-53
Valid for all (NF/Iso, NF/Fe and Ni/Fe)	● Geometric shape of the specimen as the thickness of the base material or the cylindrical form. ● The position of the measurement spot on the specimen: distance to an edge, bore, pedestal or step.	ESD20	-

NF: Non-magnetizable, electrically conducting coatings (non-ferrous metal coatings)
Iso: Insulating materials, electrically non-conducting, non-magnetizable
Fe: Magnetizable coating of steel or iron
Cu: Copper / Ni: Nickel / Zn: Zinc

ESD probes are not capable of measuring chrome coatings.

In calibration, we distinguish between normalization and corrective calibration.

Normalization

The normalization is the simplest kind of calibration and is used for adapting the measurement system to a reference point. For the measuring method of the module SIGMASCOPE®/PHA-

SCOPE®1, these are the magnetizable base materials and/or the electrically conducting coating materials. Measurements are made on a reference part that corresponds in material and shape to the actual part to be measured. It consists either only of the base material, i.e., without the coating material to be measured or only of coating material. Care should be taken during the calibration to ensure that the measurement location on the reference part is approximately at the same position where it will be on the part to be measured (curvature, distance to edge, hole, offset and step).

Corrective Calibration

The corrective calibration adjust the measurement system to the properties of the specimen. The corrective calibration not only adjusts the system to the substrate material but also to 1 to 2 coating thickness values by using so-called standards.

If the trueness is not met when making measurements on customer reference parts (customer standards), a corrective calibration should be performed.

In general, the material properties (permeability) of the specimen will differ significantly from those taken into account in the factory pre-calibration). **It is, therefore, essential to perform the normalization or corrective calibration, respectively, using uncoated reference parts (specimens) from your own production!**

With the phase-sensitive eddy-current method used, the reading is dependent on the magnetic permeability and the electrical conductivity, respectively. It is, therefore, necessary that the user produces calibration standards (base, saturation and coated calibration parts) from his *own* production.

2.10.2 Variables Influencing the Measurement of Copper Coatings on PC-Boards

The electrical conductivity of the coating materials significantly influences the measurement on non-ferrous metal coatings. A corrective calibration (adjustment of the measuring system to the specimen) using standards from in-house production is, therefore, absolutely necessary. The electrical conductivity, in turn, is significantly influenced by the temperature, such that the specimens must have the same temperature during measurement and corrective calibration.

- Protective paint coatings or air gaps up to 300 µm (11.7 mils) do not influence the measurement.

As a standard, the measuring system (ESD20 Cu probe and instrument) is pre-calibrated for measurements on copper coatings.
The measuring system must be master-calibrated for other coating/substrate material combinations. Please contact your authorized Fischer distributor or Helmut Fischer GmbH, www.helmut-fischer.com, directly for appropriate master calibration standard sets.

Depending on the required accuracy, a corrrective calibration with one or two standards may need to be performed. In general, the material properties (permeability, electrical conductivity) of the specimen will differ significantly from those taken into account in the factory pre-calibration. We therefore strongly recommend using 2 calibration standards for the corrective calibration. The corrective calibration not only adjusts the system to the substrate material (normalization) but also to 1 to 2 coating thickness values by using so-called calibration standards. Coated reference parts with known coating thickness values (measured with a different test method, e.g., x-ray flourescence method) can used as standards. Materials and shape of the calibration standards must correspond to those of the specimen to be measured. The same applies to the position of the measured areas. The position of the measurement spot on the calibration standard must correspond to that on the subsequent test specimens, i.e., the test parts from the production (same distance to edge/borehole, same curvature radius, etc.). The corrective calibration must be performed using at least one calibration standard. We recommended using 2 calibration standards from own production for the corrective calibration.

The corrective calibration applies only to the open application and the coating thickness ranges of the used standards, respectively. This means, an accurate measurement with the trueness specified in the probe data sheet is possible only in this range. A new corrective calibration (possibly in a new and different application) must be performed for measurements outside of this coating thickness range. The correction factors determined during the corrective calibration have to stored in the open application file.

2.10.3 Corrective Calibration - Cu/Epoxy

A corrective calibration should always be performed under conditions that are comparable to those of the specimen!
Same substrate material for the calibration standard and for the specimen, same curvature, etc.!

Perform the corrective calibration carefully! It determines the accuracy for the subsequent measurements. - Measurements can never be more accurate than the corrective calibration!

The influence of the electrical conductivity of the coating material must be taken into account when making corrective calibrations on non-ferrous metal coatings (Cu). The electrical conductivity is temperature-dependent, such that the temperature of the standard during corrective calibration must be the same as the temperature of the specimen during the measurement.

Required materials/standards (from own production):

- Saturation: Reference part of exclusive coating material (Cu) with a thickness that is greater than the max. measurable coating thickness. The saturation thickness is dependent on the probe type (measurement range).

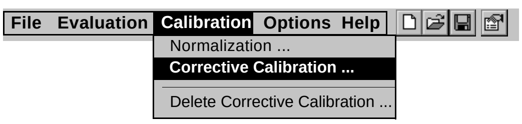
To measure for saturation, do not use the supplied Cu saturation part! It should be used for a function check only!
The supplied Cu saturation standard can be used only if the material properties (conductivity, etc.) of the specimen coating material agree with those of the supplied standard.

- Calibration standard(s): Coated part from the own production with substrate and coating materials that correspond to those of the specimen. The thickness of the coating material should be in the range of the coating thickness to be measured.

Information on creating in-house calibration standards can be found beginning on page 2-53.

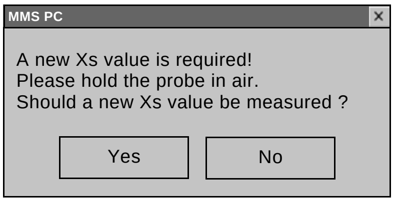
Procedure:

1. Calling the corrective calibration function:



Tap **Calibration / Corrective Calibration ...** on the display in succession using the stylus.

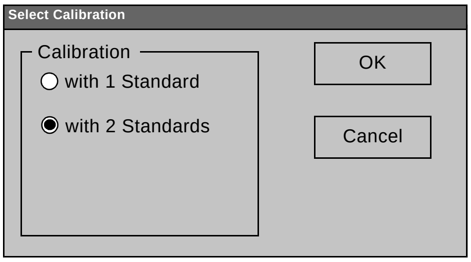
2. Get "air value":



1. Hold probe in the air. The distance to the closest object must be a minimum of 5 cm (2").
2. Tap the **Yes** button with stylus.

3. Select the number of the coated standards used for the corrective calibration:

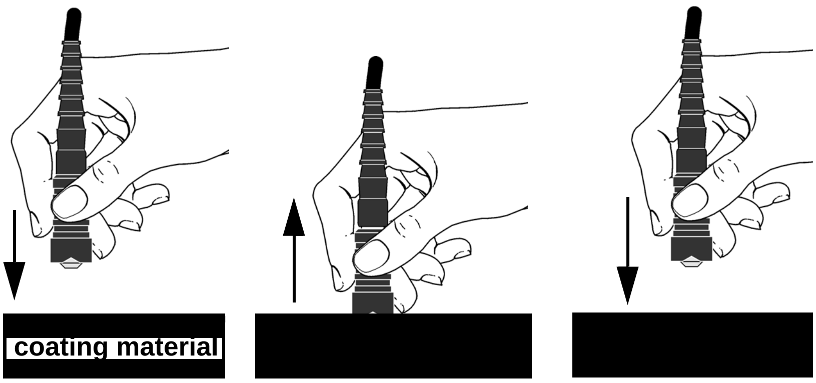
Window *Select Calibration*



1. Tap "**with 2 Standards**" to get the best measurement accuracy for the entire probe range.
2. Tap the **OK** button with the stylus to confirm the selection.

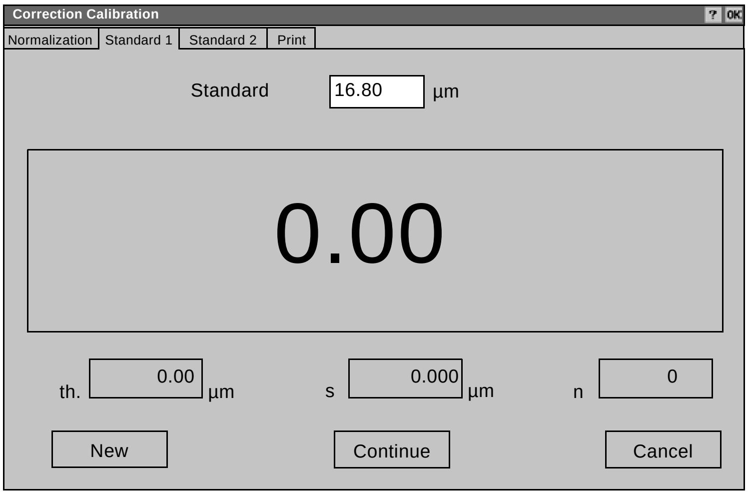
The window *Correction Calibration* opens.

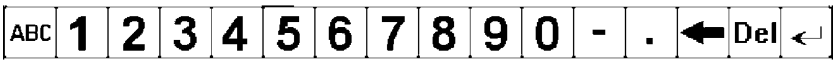
4. Measure on saturation (coating material adjustment)

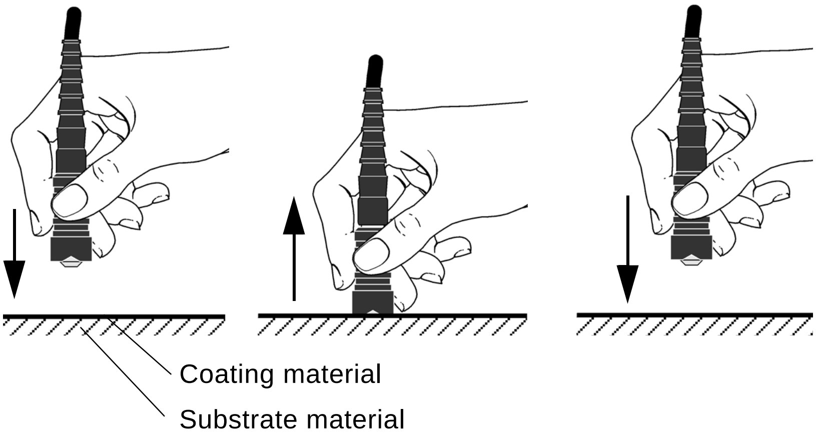


1. Perform 5 to 10 measurements on the coating material standard (=saturation, only coating material).
2. Tap **Continue** button with the stylus.

5. Measurement on Standard 1(2):







Window *Correction Calibration*

1. Check the displayed thickness value (field Standard) with the thickness value of the present standard.
   The displayed standard thickness does not correspond to the thickness of the present standard. In this case, enter the thickness that is specified on the present standard into the field "Standard": Double-tap on the entry field. Use the entry bar at the bottom of the display, tap the numbers in succession (Example: 1 6 . 8 for the coating thickness of 16.8 µm labeled on standard).

2. Perform 5 to 10 measurements on the calibration standard (1 resp. 2).

For the corrective calibration with only one standard, or after the measurement on standard 2 continue with step # 5.

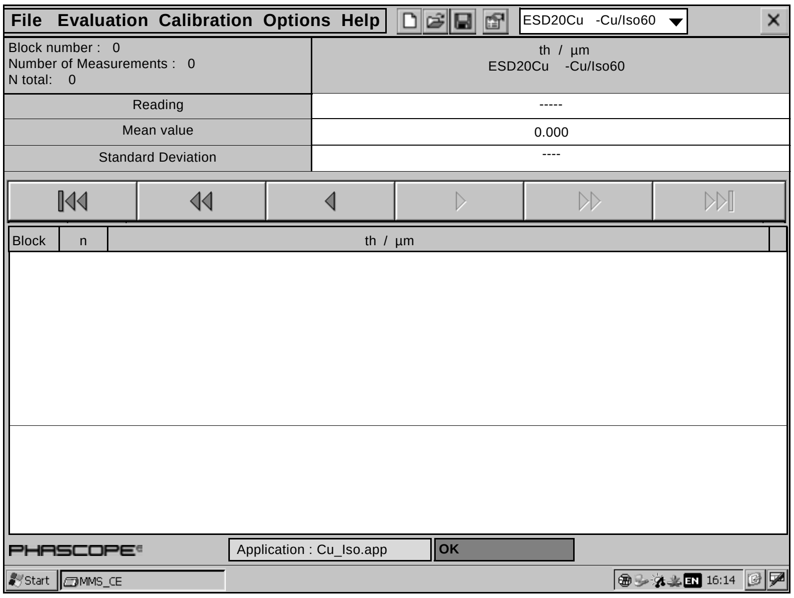
3. Tap the **Continue** button with the stylus.

4. Perform steps ***1.*** to ***2.*** with the second standard. Then continue with step # 5.

5. Tap the **Finish** button with the stylus.

   The window *Correction Calibration* closes.

6. Saving the parameters of the corrective calibration in the current application:



Measuring mode Numeric Display

1. Tap the button  with the stylus.

The corrective calibration is finished and has been stored in the open application. Thus, for this application, a new corrective calibration is not required before every measurement.

2.10.4 Variables influencing the measurement of copper or zinc coatings on steel or iron

- The electrical conductivity of the coating materials significantly influences the measurement on non-ferrous metal coatings. A corrective calibration (adjustment of the measuring system to the specimen) using typical standards from the production is, therefore, absolutely necessary. The electrical conductivity, in turn, is significantly influenced by the temperature, such that the specimens must have the same temperature during measurement and corrective calibration.
- The thickness of a non-ferrous metal coating on a non-ferrous metal substrate material can be measured if the electrical conductivity of the coating material is twice that of the substrate material.
- Zinc alloy coatings such as ZnNi or ZnFe cannot be measured due to their low conductivity.
- Rough surfaces, protective paint coatings or air gaps up to 400 µm (15.6 mils) (depending on the probe) do not influence the measurement.

As a standard, the measuring system (probe and instrument) is pre-calibrated for measurements on copper and/or zinc coatings, depending on the probe model in use.
The measuring system must be master-calibrated for other coating/substrate material combinations. Please contact your authorized Fischer distributor or Helmut Fischer GmbH directly for appropriate master calibration standard sets. www.helmut-fischer.com

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Depending on the required accuracy, a corrrective calibration with one or two standards may need to be performed. In general, the material properties (permeability, electrical conductivity) of the specimen will differ significantly from those taken into account in the factory pre-calibration. We therefore strongly recommend using 2 calibration standards for the corrective calibration. The corrective calibration applies only to the open application and the coating thickness ranges of the used standards, respectively. The correction factors determined during the corrective calibration are stored in the open application file.

2.10.5 Corrective Calibration - Zn/Fe and Cu/Fe

A corrective calibration should always be performed under conditions that are comparable to those of the specimen!
Same substrate material for the calibration standard and for the specimen, same curvature, etc.!

Perform the corrective calibration carefully! It determines the accuracy for the subsequent measurements. - Measurements can never be more accurate than the corrective calibration!

The influence of the electrical conductivity of the coating material must be taken into account when making corrective calibrations on non-ferrous metal coatings (Cu, Zn). The electrical conductivity is temperature-dependent, such that the temperature of the standard during corrective calibration must be the same as the temperature of the specimen during the measurement.

Required materials/standards (from own production):

- Saturation: Reference part of a coating material (Cu or Zn) with a thickness that is greater than the max. measurable thickness. The saturation thickness is dependent on the probe type (measurement range).

To measure for saturation, do not use the supplied Cu or Zn saturation part! It should be used for a function check only!
The supplied Cu and Zn saturation standards can be used only if the material properties (conductivity, etc.) of the specimen coating material agree with those of the supplied standards.

- Base: Uncoated specimen from own production or material that corresponds to the uncoated specimen in material properties and geometry.

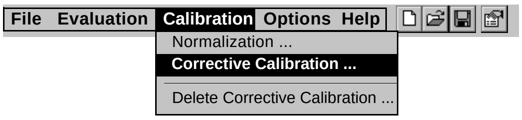
To measure on base, do not use the supplied metal plate (test plate)! It should be used for a function check only!

- Calibration standard(s): Coated part from the production with substrate and coating materials that correspond to those of the specimen. The thickness of the coating material (Cu or Zn) should be in the range of the coating thickness to be measured.

Information on creating in-house calibration standards can be found beginning on page .

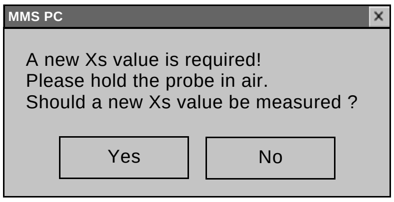
Procedure:

1. Calling the corrective calibration function:



Tap **Calibration / Corrective Calibration ...** on the display in succession using the stylus.

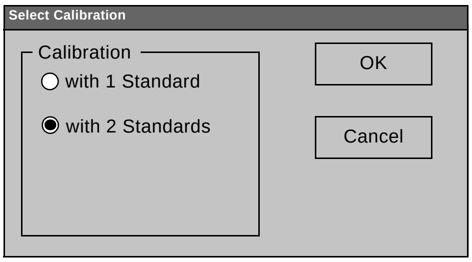
2. Get "air value":



1. Hold probe in the air. The distance to the closest object must be a minimum of 5 cm (2").
2. Tap the **Yes** button with stylus.

3. Select the number of the coated standards used for the corrective calibration:

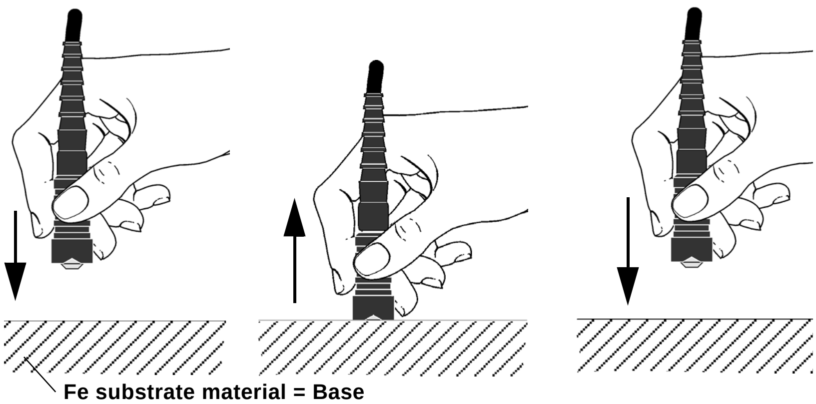
Window *Select Calibration*



1. Tap "**with 2 Standards**" to get the best measurement accuracy for the entire probe range.
2. Tap the **OK** button with the stylus to confirm the selection.

The window *Correction Calibration* opens.

4. Measure on base material (Fe, base material adjustment) :

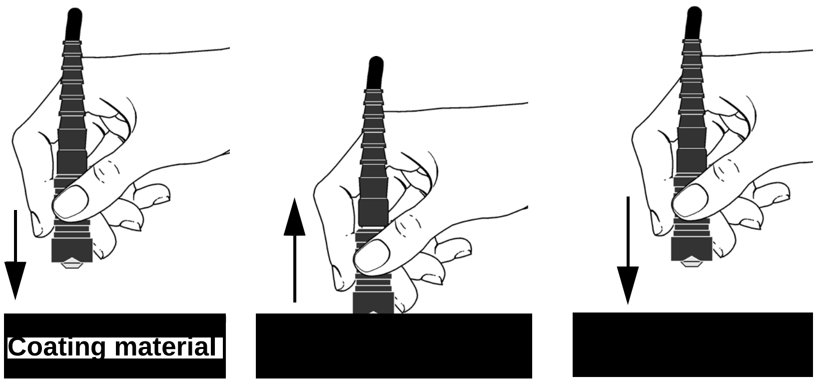


1. Perform 5 to 10 measurements on the substrate material standard (=Base).

Measurements with probe ESD30 see page 2-13.

2. Tap **Continue** button with the stylus.

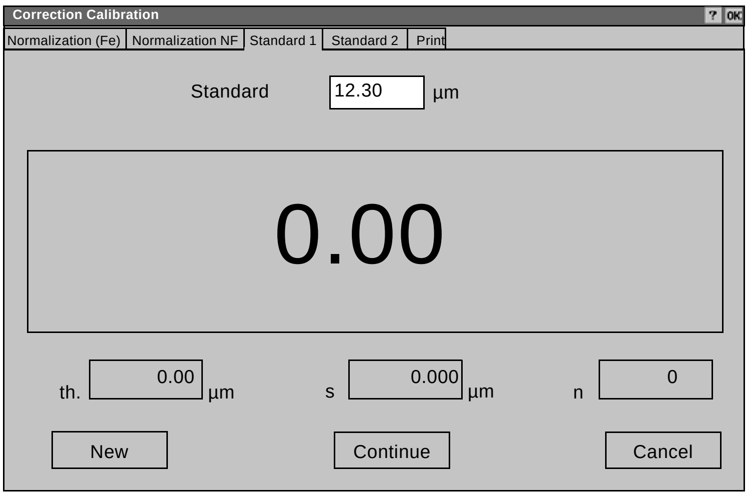
5. Measure on saturation (coating material adjustment)

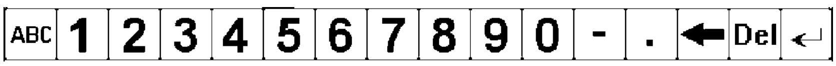


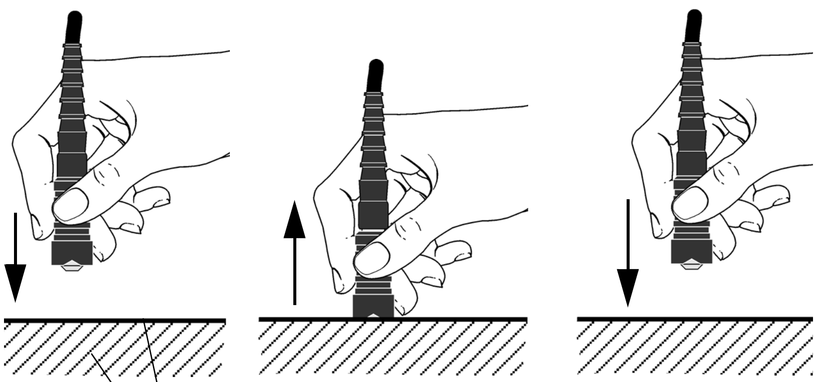
1. Perform 5 to 10 measurements on the coating material standard (=saturation, only coating material).

2. Tap **Continue** button with the stylus.

6. Measurement on Standard 1(2):







Window *Correction Calibration*

1. Check the displayed thickness value (field Standard) with the thickness value of the present standard.
   The displayed standard thickness does not correspond to the thickness of the present standard. In this case, enter the thickness that is specified on the present standard into the field "Standard": Double-tap on the entry field. Use the entry bar at the bottom of the display, tap the numbers in succession (Example: 1 2 . 3 for the coating thickness of 12.3 µm labeled on standard).

2. Perform 5 to 10 measurements on the standard 1 (or 2).

For the corrective calibration with only one standard, or after the measurement on standard 2 continue with step # 5.

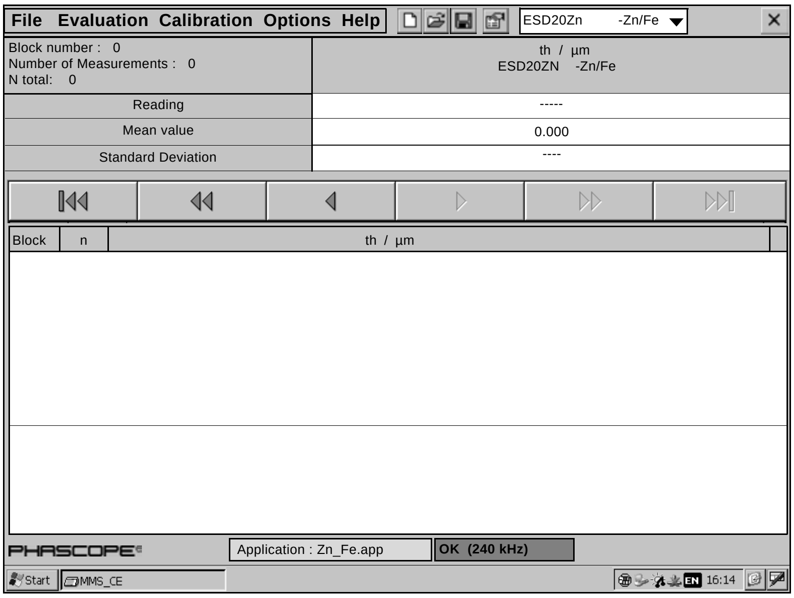
3. Tap **Continue** button with the stylus.

4. Perform steps ***1.*** to ***2.*** with the second standard. Then continue with step # 5.

5. Tap the **Finish** button with the stylus.

The window *Correction Calibration* closes.

7. Saving the parameters of the corrective calibration in the current application:



Measuring mode Numeric Display

1. Tap the button  with the stylus.

The corrective calibration is finished and has been stored in the open application. Thus, for this application, a new corrective calibration is not required before every measurement.

2.10.6 Variables Influencing the Measurement of Nickel Coatings

- The magnetic permeability of the coating and substrate materials significantly influences the measurement. A corrective calibration (adjustment of the measuring system to the specimen) using typical standards from the production is, therefore, absolutely necessary.
- The nickel coating must not be copper-backed.
- A chrome coating on top of it with a coating thickness of up to 1 µm (0.039 mils), a protective paint coating or an air gap up to 200 µm (7.8 mils) as well as a rough surface do not influence the measurement.
- Chemically deposited nickel coatings must be magnetizable. This is typically the case if the phosphor content is less than 8 %, or after heat treatment.

As a standard, the measuring system (ESD20 probe and instrument) is pre-calibrated for measurements on nickel coatings.
The measuring system must be master-calibrated for other coating/substrate material combinations. Please contact your authorized Fischer distributor or Helmut Fischer GmbH, www.helmut-fischer.com, directly for appropriate master calibration standard sets.

Depending on the required accuracy, a corrrective calibration with one or two standards may need to be performed. In general, the material properties (permeability, electrical conductivity) of the specimen will differ significantly from those taken into account in the factory pre-calibration. We therefore strongly recommend using 2 calibration standards for the corrective calibration. The corrective calibration applies only to the open application and the coating thickness ranges of the used standards, respectively. The correction factors determined during the corrective calibration are stored in the open application file.

2.10.7 Corrective Calibration - Ni/Fe

A corrective calibration should always be performed under conditions that are comparable to those of the specimen!
Same substrate material for the calibration standard and for the specimen, same curvature, etc.!

Perform the corrective calibration carefully! It determines the accuracy for the subsequent measurements. - Measurements can never be more accurate than the corrective calibration!

The influence of the electrical conductivity of the coating material must be taken into account when making corrective calibrations on non-ferrous metal coatings. The electrical conductivity is temperature-dependent, such that the temperature of the standard during corrective calibration must be the same as the temperature of the specimen during the measurement.

Required materials/standards (from own production):

- Base: Uncoated specimen from own production or material that corresponds to the uncoated specimen in material properties and geometry.

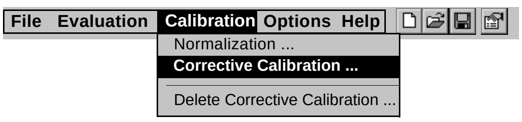
To measure on base (Fe substrate), do not use the supplied metal plate (test plate)! It should be used for a function check only!

- Calibration standard(s): Coated part from the production with substrate and coating materials that correspond to those of the specimen. The thickness of the coating material (Ni) should be in the range of the coating thickness to be measured.

Information on creating in-house calibration standards can be found beginning on page 2-53.

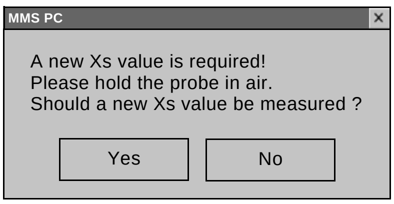
Procedure:

1. Calling the corrective calibration function:



Tap **Calibration / Corrective Calibration ...** on the display in succession using the stylus.

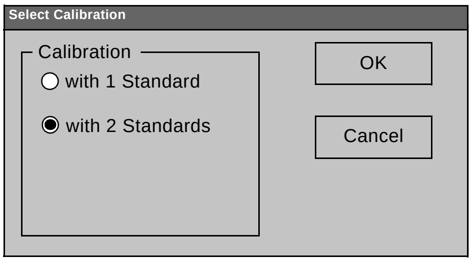
2. Get "air value":



1. Hold probe in the air. The distance to the closest object must be a minimum of 5 cm (2").
2. Tap the **Yes** button with

stylus.

3. Select the number of the coated standards used for the corrective calibration:

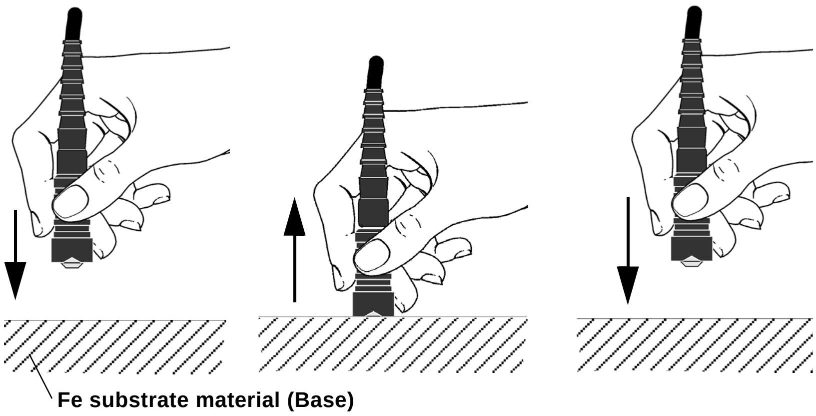


Window *Select Calibration*

1. Tap "**with 2 Standards**" to get the best measurement accuracy for the entire probe range.
2. Tap the **OK** button with the stylus to confirm the selection.

The window *Correction Calibration* opens.

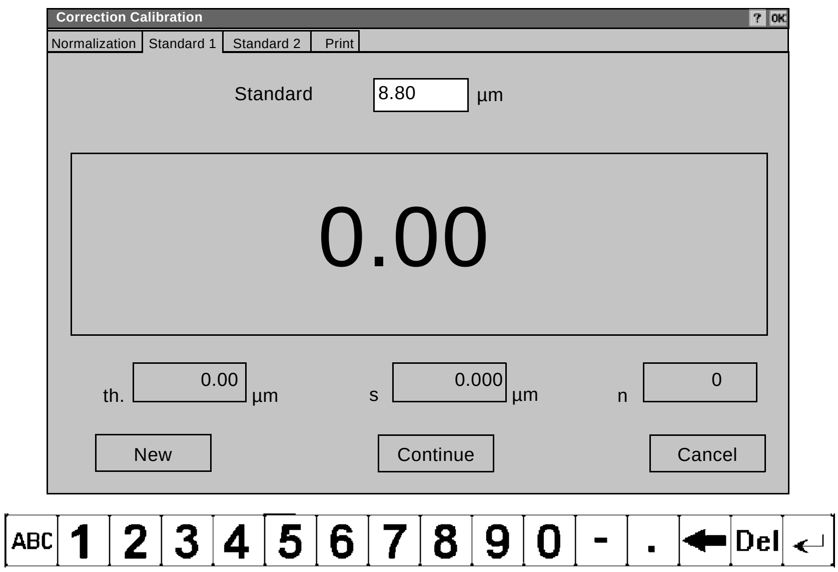
4. Measure on base material (Fe) (substrate material adjustment):



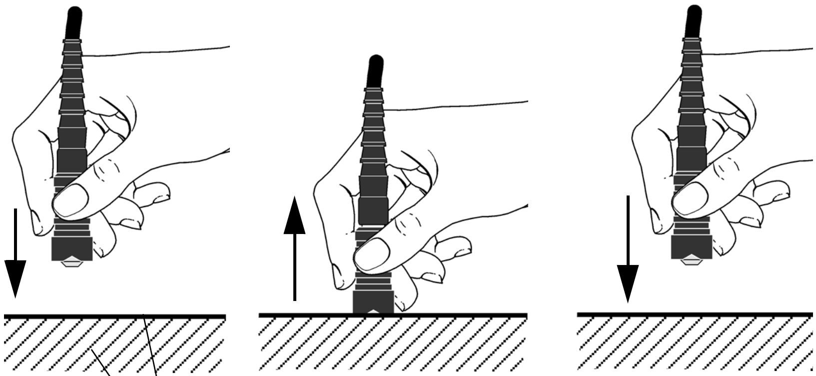
Fe substrate material (Base)

1. Perform 5 to 10 measurements on the substrate material standard (=Base).
2. Tap **Continue** button with the stylus.

5. Measurement on Standard 1(2):



1. Check the displayed thickness value (field Standard) with the thickness value of the present standard.
The displayed standard thickness does not correspond to the thickness of the present standard. In this case, enter the thickness that is specified on the present standard into the field "Standard": Double-tap on the entry field. Use the entry bar at the



bottom of the display, tap the numbers in succession (Example: 8 . 8 for the coating thickness of 8.8 µm labeled on standard).

2. Perform 5 to 10 measurements on the standard 1 (or 2).

For the corrective calibration with only one standard, or after the measurement on standard 2 continue with step # 5.

3. Tap **Continue** button with the stylus.

4. Perform steps ***1.*** to ***2.*** with the second standard. Then continue with step # 5.

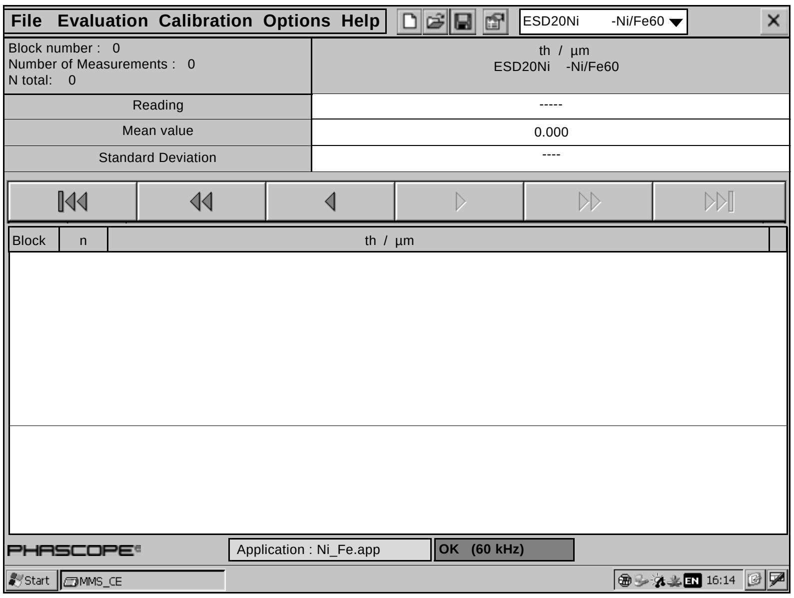
5. Tap the **Finish** button with the stylus.

The window *Correction Calibration* closes.

6. Saving the parameters of the corrective calibration in the current application:

1. Tap the button  with the stylus.

The corrective calibration is finished and has been stored in the open application. Thus, for this application, a new corrective calibration is not required before every measurement.



Measuring mode Numeric Display

2.10.8 Preparing In-House Calibration Standards

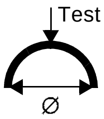
The measurement signal is dependent on the coating thickness and, depending on the probe type, also on the electrical conductivity and/or the permeability of the coating and substrate materials. A calibration standard must be prepared to take these material properties into account. Using this calibration standard in a corrective calibration, the measuring system can then be adjusted to the properties of the specimen.

A specimen is taken from the production to prepare a calibration standard. For zinc measurements, parts from a bath with the same type of electrolyte (acidic, alkaline cyanide or cyanide-free), because the conductivity of the zinc coating is defined by the electrolyte.

The specimen must exhibit a uniform coating thickness distribution in order to assign a coating thickness value to this specimen. Measurements are made at several locations of the specimen to determine the coating thickness distribution. Because only the coating thickness fluctuations are of interest and not the absolute value, even an instrument (MMS® PC2) that has not yet undergone final calibration can be used. The coating thickness distribution can now be determined based on the measurement fluctuations (standard deviation). Once a specimen with a uniform coating thickness distribution (low standard deviation) has been found from the production, the (absolute) coating thicknesses are then measured using a different measuring method (e.g., coulometric or x-ray fluorescence method). Based on the uniform coating thickness distribution, the mean value from these measurements specifies the coating thickness value for the specimen. By assigning a coating thickness value, the specimen becomes a calibration standard. A measurement spot with the assigned thickness value, and where the measurements will take place during the corrective calibration, must be marked on the calibration standard.

2.10.9 Probe Specifications

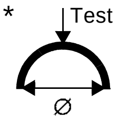
Probe types ESD20

Probe type	ESD20 Zn	ESD20 Zn	ESD20 Cu	ESD20 Ni
Coating/substrate material	Zn/Fe	Cu/Fe	Cu/Iso	Ni/Fe
Measurement range (Probe frequency)	2 ... 200 µm [0.08 ... 8 mils] (240 kHz)	1 ... 200 µm [0.04 ... 8 mils] (60 kHz)	1 ... 270 µm 0.04 ... 10.8 mils] (60 kHz) 1 ... 100 µm [0.04 ... 4 mils] (240 kHz)	2 ... 100 µm [0.08 ... 4 mils] (60 kHz) 1 ... 50 µm [0.04 ... 2 mils] (240kHz)
*Repeatability precision referenced to Fischer Standards (the largest value applies)	0.2 µm [0.008 mils] or 1 % of reading	0.07 µm [0.0056 mils] or 0.5 % of reading	0.02 µm [0.0008 mils] or 0.5 % of reading	0.05 µm [0.002 mils] or 1 % of reading
*Trueness referenced to Fischer Standards	Depending on the electr. conductivity of the coating material. For parts from an electroplating bath: typical ± 0.2 µm [0.008 mils] or ± 1 % of reading (the largest value applies)			Depending on the permeability of the nickel coating and of the substrate material.
Probe tip diameter	5.5 mm [0.22"]			
Probe tip material	hard synthetic material			
Distance compensation	up to 400 µm [16 mils]		up to 300 µm [12 mils]	up to 200 µm [8 mils]
*  Ø for ≥10 % measurement deviation at the master calibration on flat surface.	Ø ≤ 4 mm [0.156"] (at 25 µm [1 mils] Zn coating)		Ø ≤ 6 mm [0.234"] (at 100 µm [4 mils] Cu coating)	Ø ≤ 4 mm [0.156"] (at 25 µm [1 mils] Ni coating)
*Test area diameter for error ≥ 10 %	Ø ≤ 6 mm [0.234"]		Ø ≤ 20 mm [0.78"]	Ø ≤ 6 mm [0.234"]
*Substrate material thickness for error ≥ 10 %	≤0.1 mm [0.04 mils]		-	≤0.1 mm [0.04 mils]
*Saturation thickness for error ≥ 10 %	-		≤ 0.6 mm [0.024 mils]	-
Probe length	110 mm [4.29"]			
Probe diameter	16 mm [0.624"]			

Probe type	ESD20 Zn	ESD20 Zn	ESD20 Cu	ESD20 Ni
Coating/substrate material	Zn/Fe	Cu/Fe	Cu/Iso	Ni/Fe
Probe/measurement frequency	240 kHz	60 kHz	60 kHz (1 ... 270 µm) [0.04 ... 10.8 mils] 240 kHz (1 ... 100 µm) [0.04 ... 4 mils]	60 kHz (2 ... 100 µm) [0.08 ... 4 mils] 240 kHz (1 ... 50 µm) [0.04 ... 2 mils]
Measurement application Master Calibration	Specimen with flat, smooth surface			

* The specifications only be valid for probes master calibrated together with the used instrument.

Probes ESD2.4 and ESD30

Probe type	ESD2.4	ESD30 Zn	ESD30 Cu
Coating/substrate material	Zn/Fe	Zn/Fe	Cu/Fe
Measurement range (Probe frequency)	2 ... 150 µm [0.08 ... 6 mils] (1250 kHz)	10 ... 2000 µm [0.4 ... 80 mils] (3 kHz)	10 ... 1000 µm [0.4 ... 40 mils] (3 kHz)
*Repeatability precision referenced to Fischer Standards (the largest value applies)	≤ 0.3 µm [0.012 mils]	0.2 µm [0.008 mils] or 0.5 % of reading	0.2 µm [0.008 mils] or 0.5 % of reading
*Trueness referenced to Fischer Standards	Depending on the electr. conductivity of the coating material. For parts from an electroplating bath: typical ± 0.2 µm [0.008 mils] or ± 1 % of reading (the largest value applies)		
Probe tip diameter	3.3 mm [0.22"]	flat, 15 mm [0.59"]	
Probe tip material	plastic	-	-
Distance compensation	up to 250 µm [10 mils]	up to 700 µm [27.3 mils]	
*  Test spot Ø for ≥10 % measurement deviation at the master calibration on flat surface.	⌀ ≤ 2 mm [0.078"] (at 25 µm [1 mils] Zn coating)	⌀ ≤ 22 mm [0.87"] (at 200 µm [7.8 mils] Cu coating)	
*Test area diameter for error ≥ 10 %	⌀ ≤ 3.5 mm [0.138"]	⌀ ≤ 15 mm [0.59"]	
*Substrate material thickness for error ≥ 10 %	≤ 0.1 mm [2 mils]	≤ 0.2 mm [8 mils]	
Probe length	110 mm [4.29"]	130 mm [5.12"]	
Probe diameter	10 mm [0.39"]	18 mm [0.71"]	
Probe/measurement frequency	1250 kHz	3 kHz	
Measurement application Master Calibration	Specimen with flat, smooth surface		

* The specifications only be valid for probes master calibrated together with the used instrument.

2.11 Measurements with the SIGMASCOPE®/PHASCOPE®2 Module

Measurements of Copper Thicknesses in Through-Holes of PC-Boards

The module includes the phase sensitive Eddy current test method and works only in combination with the module SIGMASCOPE®/PHASCOPE®1.

2.11.1 Influencing Variables Taken into Consideration - Cu/Through-Hole

Main variables influencing the measurement of copper thicknesses in through-holes of pc-boards:

- Missing system adjustment of instrument and connected probe,
  Normalization, 🗐 2-58, or **corrective calibration**, 🗐 2-60.
- Thickness of the pc-board;
  is taken into account by entering the pc-board thickness when making measurements; 🗐2-67.
- Electrical conductivity and temperature of the copper coating.
  These variables can be taken into account by entering a correction factor when making measurements, 🗐 2-69.
- A Sn or SnPb coating in the through-hole, 🗐 2-70.
- Measurement position in the longitudinal axis of the through-hole, 🗐 2-73.
- Handling of the probe, 🗐 2-71.

ⓘ It is not possible to measure the copper coating thickness under chemically or galvanically deposited nickel coatings when the nickel coating exhibits ferromagnetic behavior.

ⓘ A corrective calibration (adjustment of the measuring system to the copper material) with in-house calibration standards must be performed when measuring electroless deposited copper, 🗐 2-66. The minimum measureable coating thickness is 5 µm.

2.11.2 Normalization - Cu/Through-Hole

A normalization is used to perform a system adjustment, where the coating material (Cu) is used as a reference.

The normalization supports the measurement reliability!

Required materials: Cu Reference Board 603-944

The copper quality of the Cu Reference Board 603-944 corresponds to a modern electroplating bath and is sufficient for typical practical applications.

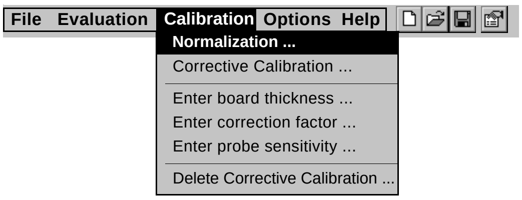
! The electrical conductivity is temperature-dependent, so it is important that the temperature of the Cu Reference Board during normalization must be the same as the temperature of the pc boards during the measurements!

When

- **Always after instrument power up.**
- **After longer measurement breaks.**
- **When the ambient conditions change** (e.g., large temperature fluctuations or changes).

Procedure:

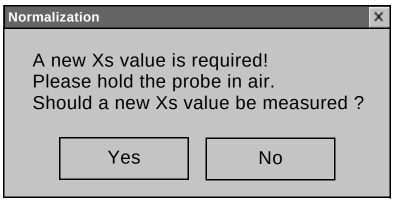
1. Calling the normalization function:



Open window *Normalization*

Tap **Calibration / Normalization ...** on the display in succession using the stylus.

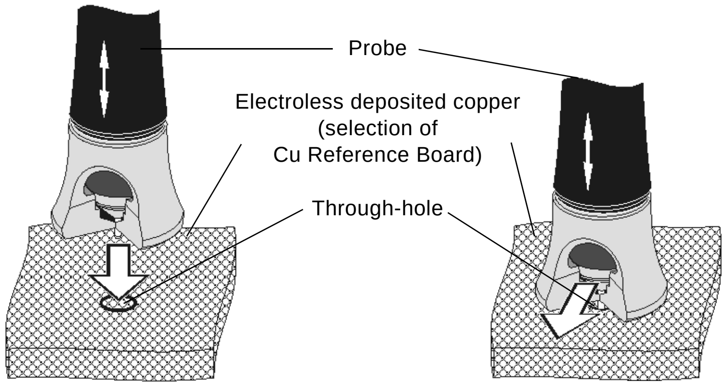
2. Get "air value":



Window *Normalization*

1. Hold probe in the air. The distance to the closest object must be a minimum of 5 cm (2").
2. Tap the **Yes** button with stylus.

3. Measure on saturation (Cu Reference Board 603-944):



Insert the probe vertically into the through-hole. After placing the probe foot, press the probe tip **lightly** onto the hole wall in the area of the V-shaped cutout of the probe foot. Wait (about 1 to 2 seconds) until the measured value appears on the display. Then remove the probe vertically from the through-hole to avoid tilting.

Window *Normalization*

1. Insert the probe several times (5 to 10 times) in the through-hole of the Cu Reference Board.

Probe ESL080V: Always measure with the attached distance ring 1,6 placed on the Cu Reference Board!

Handling of the probe beginning on page 5-13.

2. Tap **Finish** button with the stylus.

4. Saving the normalization in the current application:

Tap the button with the stylus.

If applicable, enter the pc-board thickness and the correction factor before measurement. beginning on page 5-9.

Saving Normalization in the current application

Now measurements can be made.

2.11.3 Corrective Calibration - Cu/Through-Hole

Necessary

- If the trueness is not met when making measurements, a so-called corrective calibration should be performed by using the PTH Calibration Standard Board 603-982.
- Adjustment the measuring system (instrument and probe) to in-house calibration standards.

A corrective calibration should always be performed under conditions that are comparable to those of the specimen!
Same substrate material for the calibration standard and for the specimen, same curvature, etc.!

Perform the corrective calibration carefully! It determines the accuracy for the subsequent measurements. - Measurements can never be more accurate than the corrective calibration!

The influence of the electrical conductivity of the coating material must be taken into account when making corrective calibrations on non-ferrous metal coatings (Cu). The electrical conductivity is temperature-dependent, such that the temperature of the calibration standard board (standard) during corrective calibration must be the same as the temperature of the pc board during the measurement.

Required materials/standards

Saturation:

- Cu Reference Board (603-944) from Fischer.
  The copper quality of the Cu Reference Board 603-944 corresponds to a modern electroplating bath and is sufficient for typical practical applications.

Calibration standard(s):

- PTH Calibration Standard Board (603-982) from Fischer.
  The copper quality of the PTH Calibration Standard Board 603-982 corresponds to a modern electroplating bath and is sufficient for typical practical applications.

  Or

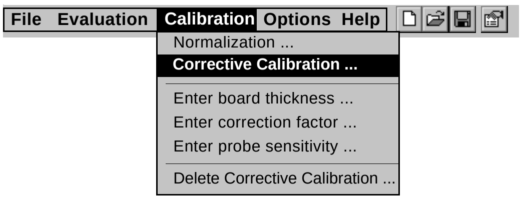
- In-house calibration standards

Information on creating in-house calibration standards can be found beginning on page 2-66.

The electrical conductivity is temperature-dependent, so it is important that the temperature of the Cu Reference Board and the PTH Calibration Standard Board during corrective calibration must be the same as the temperature of the pc boards during the measurements!

Procedure:

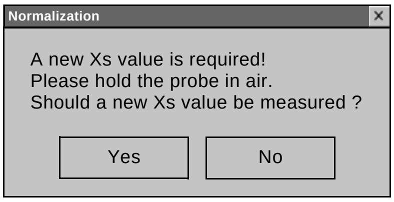
1. Calling the corrective calibration function:



Open window *Correction Calibration*

Tap **Calibration / Corrective Calibration ...** on the display in succession using the stylus.

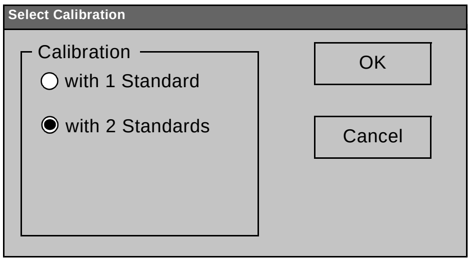
2. Get "air value":



Window *Normalization*

1. Hold probe in the air. The distance to the closest object must be a minimum of 5 cm (2").
2. Tap the **Yes** button with stylus.

3. Select the number of standards used for corrective calibration:



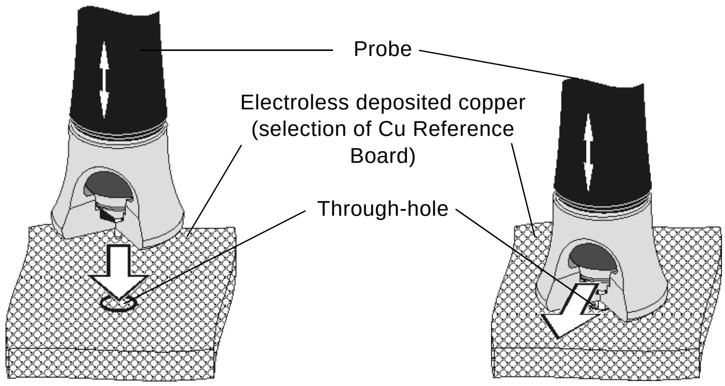
Window *Select Calibration*

In this case standard means the through-hole of the PTH Cal. Standard Board.

1. Tap "**with 2 Standards**" to get the best measurement accuracy for the entire probe range.
2. Tap the **OK** button with the stylus to confirm the selection.

The window *Correction Calibration* opens.

4. Measure on saturation (Cu Reference Board 603-944):



Insert the probe vertically into the through-hole. After placing the probe foot, press the probe tip **lightly** onto the hole wall in the area of the V-shaped cutout of the probe foot. Wait (about 1 to 2 seconds) until the measured value appears on the display. Then remove the probe vertically from the through-hole to avoid tilting.

Window
Correction Calibration
Tab *Normalization*

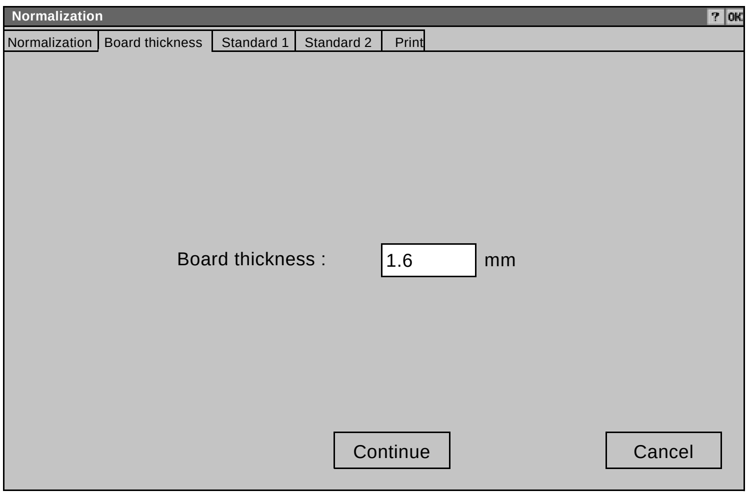
1. Insert the probe several times (5 to 10 times) in the through-hole of the Cu Reference Board.

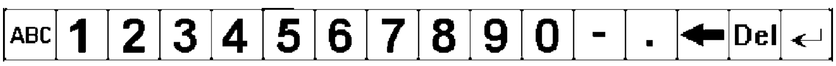
Probe ESL080V: Always measure with the attached distance ring 1,6 placed on the Cu Reference Board!

Handling of the probe beginning on page 2-71.

2. Tap **Continue** button with the stylus.

5. Enter the PC-board thickness:





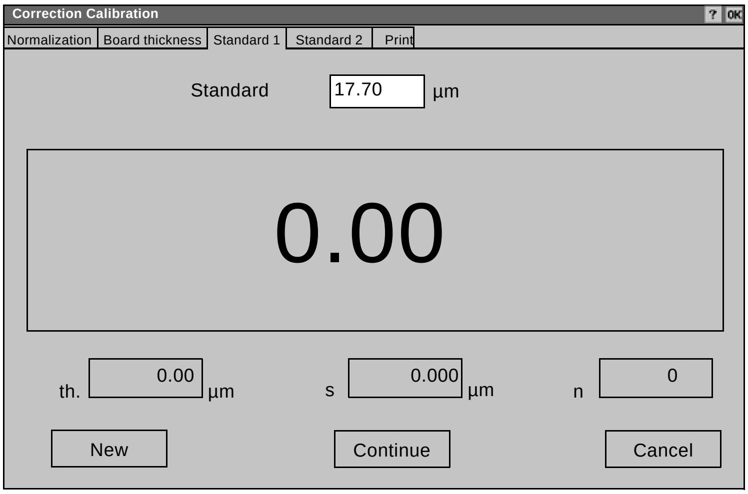
Window
Correction Calibration
Tab *Board thickness*

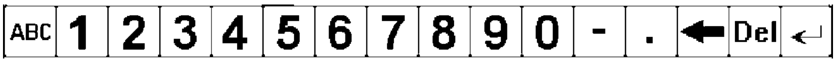
By default, the board thickness (1.6 mm or 63.0 mils) of the PTH Cal. Standard Board is specified.

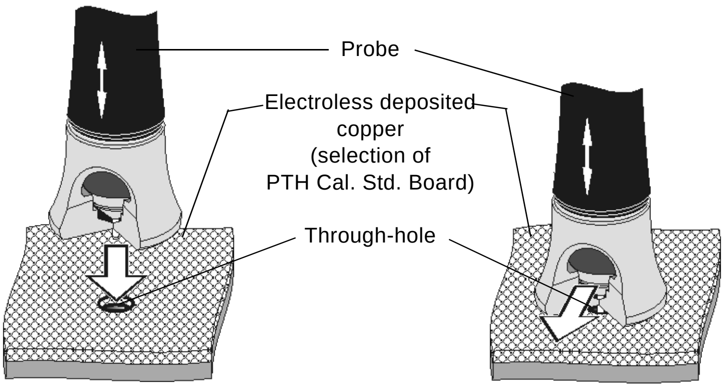
Change this information only if you use in-house calibration standards with different board thicknesses! - Double-tap on the entry field. Use the entry bar at the bottom of the display, tap the numbers in succession.

1. Tap the **Continue** button with the stylus.

6. Measure in the through-hole 1 (2) of the PTH Cal. Standard Board 603-982 (or in-house calibration standard) :







Insert the probe vertically into the through-hole. After placing the probe foot, press the probe tip **lightly** onto the hole wall in the area of the V-shaped cutout of the probe foot. Wait (about 1 to 2 seconds) until the measured value appears on the display. Then remove the probe vertically from the through-hole to avoid tilting.

Window
Correction Calibration
Tab *Standard1 (2)*

1. Check the displayed thickness value (field Standard) with the thickness value of the present standard.
The displayed standard thickness does not correspond to the thickness of the present standard. In this case, enter the thickness that is specified on the present standard into the field "Standard": Double-tap on the entry field. Use the entry bar at the bottom of the display, tap the numbers in succession (Example: 1 7 . 7 for the coating thickness in the through-hole of 17.7 µm labeled on the PTH Cal. Standard Board).

2. Perform 5 to 10 measurements on the PTH Cal. Standard Board (1 resp. 2).

Insert the probe several times (5 to 10 times) in the respective through-hole of the calibration board.

Probe ESL080V: Always measure with the attached distance ring 1,6 placed on the PTH Cal. Standard board!

For the corrective calibration with only one standard, or after the measurement on standard 2 (through-hole on calibration board) continue with step # ***5***.

3. Tap the **Continue** button

with the stylus.

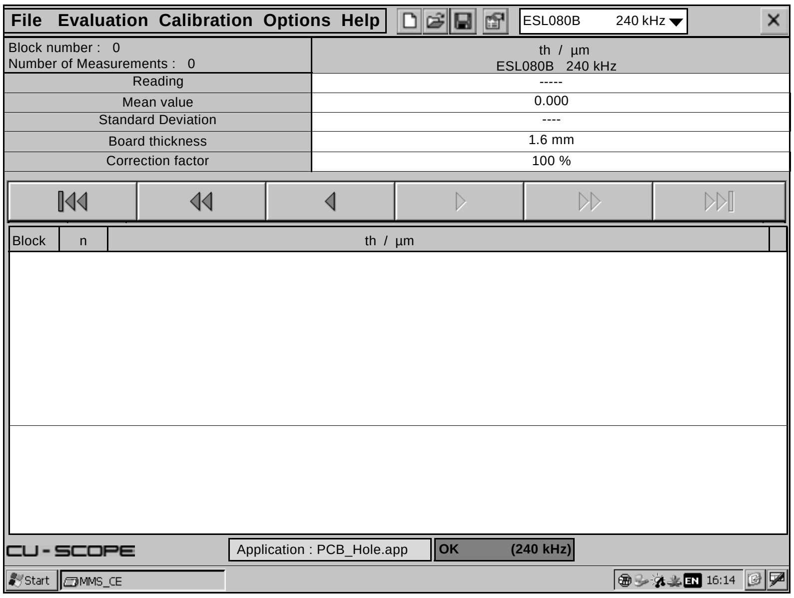
4. Perform steps **6.***1.* to **6.***2.* with the second standard. Then continue with step # **6.***5*.

If problems occur, see the Section “Troubleshooting” on Page .2-65.

5. Tap the **Finish** button with the stylus.

The window *Correction Calibration* closes.

7. Saving the parameters of the corrective calibration in the current application:



Saving the correction calibration

Tap the button  with the stylus.

The corrective calibration is finished and has been stored in the open application. Thus, for this application, a new corrective calibration is not required before every measurement.

The instrument is now ready to make measurements. If applicable, enter the pc-board thickness and the correction factors for the temperature and the electr. conductivity, beginning on page 2-67.

2.11.4 Trouble shooting

Potential problems that may occur during the corrective calibration and their corrections.

Message	Cause / Correction
Reading outside interval! *It was not possible to calculate the parameters.*	The coating thickness measured in the through-hole does not fit the stated nominal thickness. - Measurement performed in the wrong through-hole by mistake. - Coatings in the through-hole defective, e.g., due to heavy wear, dirt, etc. Correction: Tap the control button **New** and remeasure in the correct through-hole. If applicable, redo the corrective calibration.

2.11.5 Preparing a Calibration Standard

for the Coating Thickness Measurement in Through-Holes of PC-Boards

It is necessary to prepare in-house calibration standards for chemically deposited copper coatings, because its electr. conductivity differs from that of galvanically deposited copper.

The coating thicknesses are measured in several through-holes at a pc-board from the production. Because only the coating thickness fluctuations are of interest and not the absolute value, even an instrument (PMP10 or MMS® PC2) that has not yet undergone final calibration can be used. The deviations of the coating thickness should be in a range of 1 % but must not exceed 1.5 %. Mark the through-holes that have coating thicknesses within this range (n through-holes). Measure the coating thickness in n-1 through-holes using a competing measurement method (e.g., cross-cutting). The averaged coating thickness value across all n-1 through-holes is then assigned to the n^{th} through-hole. The n^{th} through-hole now serves as the standard for the corrective calibration.

Preparing a standard for the copper coating thickness in through-holes is elaborate and difficult. As a rule, cross-cutting is used to determine the absolute coating thickness values. The main problem with this method is in the preparation of the cross-cuts. Significant errors can occur in the process.

2.11.6 Probe Specification

Probes ESL080B and ESL080V

Probe type	ESL080B	ESL080V
Coating/substrate material	Cu/Epoxy	
Measuring range	5 ... 100 µm [0.2 ... 3.9 mils]	
*Repeatability precision referenced to the Fischer calibration hole board 603-982 (the largest value applies)	5 ... 30 µm: 0.3 µm 30 ... 100 µm : ≤ 1 % of reading [0.2 ... 1.2 mils: 0.12 mils ; 1.2 ... 3.9 mils: ≤ 1 % of reading]	
*Trueness referenced to Fischer PTH Calibration Standard Board 603-982	5 ... 20 µm: ± 0.4 µm 20 ... 100 µm : ≤ 2 % of reading [0.2 ... 0.8 mils: ± 0.016 mils ; 0.8 ... 3.9 mils: ≤ 2 % of reading]	
Smallest through-hole diameter	0.8 ... 2 mm [32 ... 80 mils]	
Smallest board thickness	0.5 mm [19.5 mils]	1.6 mm [63 mils]
Greatest board thickness for a measurement in the center of the longitudinal axis of the through-hole	1.6 mm [63 mils]	8 mm [0.312“]
Probe length (complete)	130 mm [5.1"]	135 mm [5.31“]
Probe/measurement frequency	240 kHz	
Application master calibration (pre-factory calibration	PTH Calibration Standard Board (603-982)	

* The specifications only be valid for probes master calibrated together with the used instrument.

Measurement of the Copper Coating Thickness in Through-Holes of PC-Boards

The module SIGMASCOPE®/PHASCOPE®2, together with the probe models ESL080B and ESL080V, is ideally suited for the quick, accurate and non-destructive measurement of the thickness of copper platings in plated through-holes of printed circuit boards.

The main influencing variables at the measurement of the copper coating thickness in through-holes of pc-boards are:

- Missing system adjustment of instrument and connected probe, **Normalization**, 🗐 2-58, or **corrective calibration**, 🗐 2-60.
- Thickness of the pc-board;
  is taken into account by entering the pc-board thickness when making measurements; 🗐 2-67.
- Electrical conductivity and temperature of the copper coating.
  These variables can be taken into account by entering a correction factor when making measurements, 🗐 2-69.
- A Sn or SnPb coating in the through-hole, 🗐 2-70.
- Handling of the probe, 🗐 2-71.
- Measurement position in the longitudinal axis of the through-hole, 🗐 2-73.

2.11.7 Board Thickness

> ⓘ The thickness of the laminate, or of the interim layers is negligible for practically occurring applications.

The influence of the respective board thickness can be taken into account by entering the board thickness, as long as the pc-board thickness is at least 0.5 mm (19.7 mils) and the measuring system (instrument and probe) has received a normalization using the Cu Reference Board 603-944 (pc-board thickness: 1.6 mm (63 mils)).
Changes in the pc-board thickness of less than ±10 % will lead to deviations in the reading of about 2 % regardless of the copper thickness measured. In practical applications, these deviations are usually negligible.

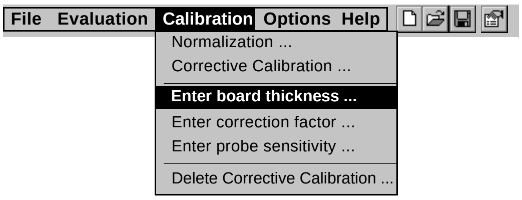
Thickness entries: 0.5 ... 8 mm [19.7 ... 315 mils].

Default setting: 1.6 mm [63 mils]

Entry for pc board thicknesses > 8 mm [315 mils]: 8 mm [315 mils]

Procedure

1. Open the window for the board thickness entry:

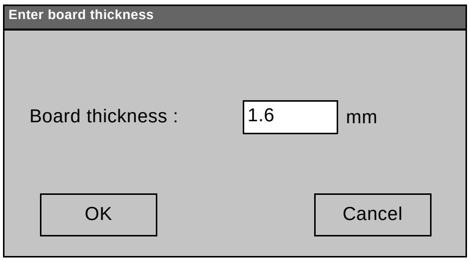


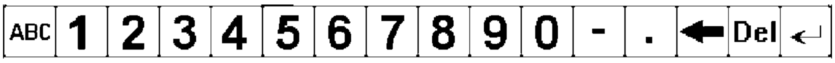
Open window *Enter board thickness*

Tap **Calibration** / **Enter board thickness ...** on the display in succession using the stylus.

The window *Enter board thickness* opens.

2. Enter the respective board thickness:





Window *Enter board thickness*

Double-tap on the entry field (to the right of Board thickness). Use the entry bar at the bottom of the display, tap the numbers in succession.

Default setting: 1.6 mm (63 mils)

Entry range: 0.5 to 8 mm (19.5 to 315 mils)

3. Tap the OK button, with the stylus to confirm the entry.

Save the entry and close the window

Entering a board thickness applies exclusively to the open application (measurement file).

Using the Distance Rings!

If the board thickness is below the minimum thickness for the respective probe type (ESL080B or ESL080V), a distance ring is required for the measurement to ensure that the measuring element in the probe tip is located in the longitudinal axis of the pc-board through-hole. Additional information for using the distance rings can be found beginning on Page 2-73.

2.11.8 Correction Factor for Conductivity and Temperature

Conductivity and temperature differences from the normalization or corrective calibration that have occurred during the measurement are taken into account with the correction factor.

The electrical conductivity of the galvanically deposited copper depends to a large extent on the bath composition. The Cu Reference Board 603-944 and the PTH Calibration Standard Board 603-982 corresponds in its copper quality to a modern electroplating bath and should be sufficient for the measuring system adjustment (normalization, corrective calibration) in typical practical applications.

If the electrical conductivity of the Cu Reference Board 603-944 or of the PTH Calibration Standard Board 603-982 is significantly different from that of the respective specimen (for example, due to specific bath conditions or electroless deposited copper), a corrective calibration using standards that have been produced in-house is required.

Information on creating in-house calibration standards can be found beginning on page 2-66.

A correction factor can be entered if **the electrical conductivity is known**. For example, if the electrical conductivity of the copper to be measured is 4 % lower than the copper of the PTH Calibration Standard Board (603-982), 96 must be entered as the correction factor.

The **temperature of the copper** influences the electrical conductivity measurement and thus the reading. As the temperature increases, the electrical conductivity reading decreases. Thus, different temperatures between the normalization or corrective calibration and the measurement must be taken into account! If one assumes that the galvanically deposited copper has approximately the same temperature coefficient as pure copper, a 4 % conductivity change must be taken into account for every 10 degrees of temperature deviation versus the temperature during the normalization or corrective calibration. This is done with the correction factor as well.
Example: Temperature of the PTH Calibration Standard Board: +20 °C, temperature of the copper coating to be measured: +30 °C. In this case, the displayed thickness reading would be low by 4 %, unless 96 is entered as a correction factor.

If applicable, the correction factors (electrical conductivity and temperature) are added together.

Enter Correction Factor

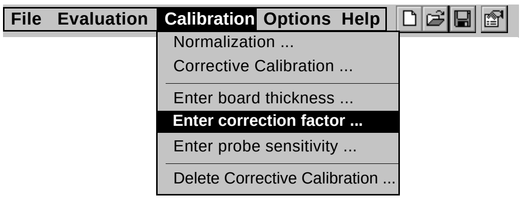
The correction factor is entered in percentage points. For example, if the readings are 20 % below the nominal thickness (reference value from a cross-cut, for example), 80 % must be entered as the correction factor in order to display the correct reading.

Default setting: 100 % (no correction)

Entering a correction factor applies exclusively to the open application (measurement file).

Procedure

1. Open the window for the factor entry:

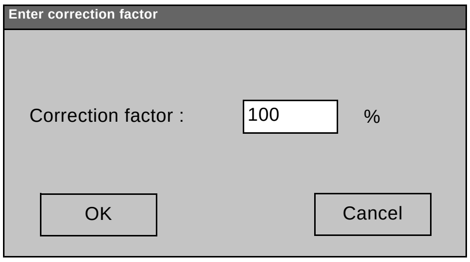


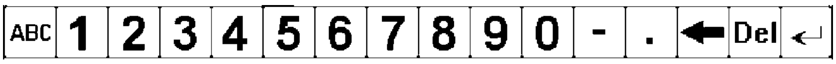
Open window
Enter correction factor

Tap **Calibration** / **Enter correction factor...** on the display in succession using the stylus.

The window *Enter correction factor* opens.

2. Change factor:





Window
Enter correction factor

Double-tap on the entry field (to the right of Correction factor). Use the entry bar at the bottom of the display, tap the numbers in succession.

Default setting: 100 %

3. Tap the OK button, with the stylus to confirm the entry.

Save the entry and close the window

2.11.9 Sn or SnPb Coating

Due to the significantly lower electrical conductivity when compared to copper, an SnPb coating in the through-hole indicates an apparent increase of the copper coating thickness by about 1/6 (only an approximate value) of the true copper coating thickness. Example: 20 µm copper coating with a 10 µm SnPb coating: Displayed reading: 21.6 µm. A correction can be performed by entry a correction factor, 2-69.

2.11.10 Handling of the Probe Models ESL080...

Probe models ESL080... (ESL080B and ESL080V) are special probes for measurements of the copper coating thickness in bore-holes of pc-boards.

⚠ **When using measurement probes of the ESL080... type, be careful not to cause injury to yourself or others with the probe tip!**
Put the red protective cap on the probe tip after a measurement or for storage purposes!

To measure and normalize/calibrate, <u>always insert the probe tip vertically</u> into the bore-hole and remove it vertically from the bore-hole! The tips of the measurement probe models ESL080... are very sensitive to mechanical stress.

Carefully remove electrolyte residue prior to making measurements!
The probe tip is not acid-proof and can be damaged by acid wetting!

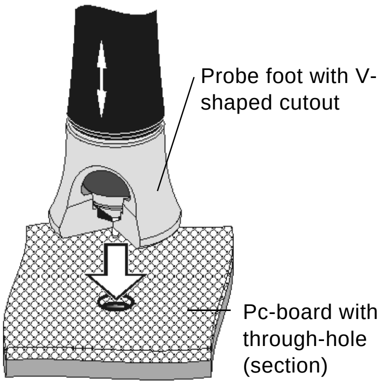
Using force when inserting or removing the probe will lead to probe damage!
It is easy to tilt the probe tip when removing it. In such cases, please do not use force; instead push the tip back into the bore-hole and then try again to pull it out vertically

Do not try to straighten a bent probe tip! This will inevitably lead to breakage of the probe tip!
Measurements can be made with a bent probe tip if it is mechanically possible. This has no effect on the accuracy and repeatability precision of the measurement.

The probe tip must not protrude from the through-hole at the bottom of the pc-board! This would lead to erroneous readings!
In such cases, use the appropriate distance ring for the measurement. Ref 2-73.

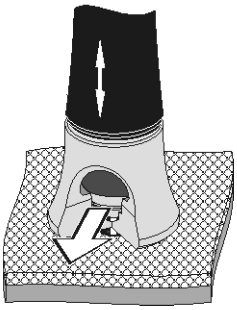
Making measurements with ESL080... type probes

1.



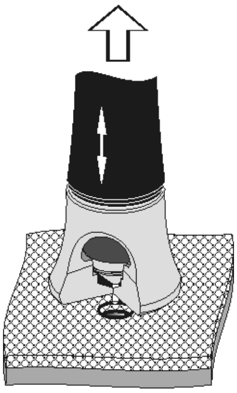
Insert the probe **vertically** into the bore-hole!

2.



After placing the probe foot, press the probe tip **lightly** onto the hole wall in the area of the V-shaped cutout of the probe foot. Wait (about 1 to 2 seconds) until the measured value appears on the display.

3.



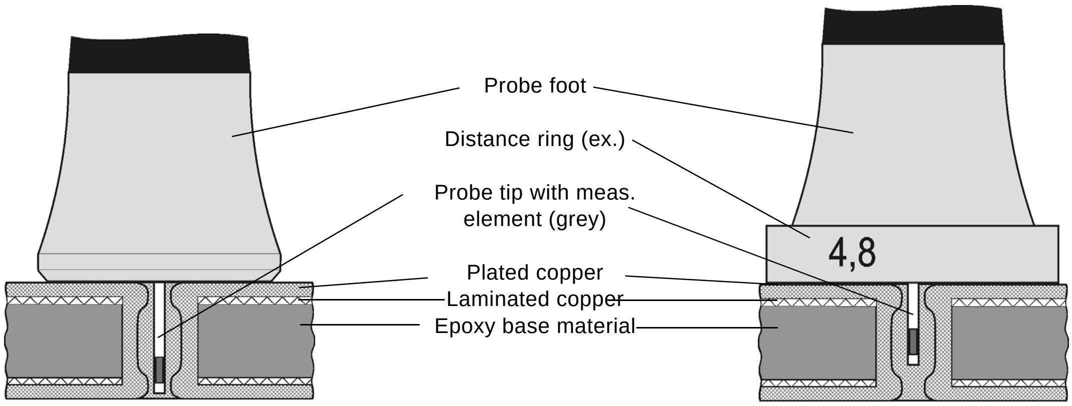
Remove the probe **vertically** from the through-hole to avoid tilting.

Lift the probe about 3 cm off the pc-board before making the next measurement.

! **When not in use, always place the red protective cap on the probe foot.**

2.11.11 Use of the Distance Rings (= Measurement Rings)

By attaching distance rings to the probe foot, the measuring element of the probe can be centered in the longitudinal axis of the through-hole (sleeve center) in a pc-board thickness range from 0.5 to 8 mm. This allows for measurements in the sleeve center, which is the thinnest and therefore most critical location due to the electroplating process.



Example for positioning the measuring element in the through-hole when making measurements with (right figure) and without (left figure) a distance ring.

Measurement probe ESL080B:

The measurement probe ESL080B always measures at a depth of 0.8 mm. Thus, attach the distance ring to the probe foot to make measurements at pc-board thicknesses between 0.5 and 1 mm.

Distance ring 0.5 - 1 (included with shipment): for pc-board thicknesses from 0.5 to 1 mm.

Measurement probe ESL080V: Distance ring set 604-088 (accessory)

The measurement probe ESL080V always measures at a depth of 4.1 mm. Thus, attach the appropriate distance ring to the probe foot to make measurements at pc-board thicknesses between 0.5 and 8 mm.

Distance ring 1.6: for pc-board thicknesses from 1.6 mm ± 0.5 mm
Distance ring 2.4: for pc-board thicknesses from 2.4 mm ± 0.5 mm
Distance ring 4.8: for pc-board thicknesses from 4.8 mm ± 0.5 mm
Distance ring 6.6: for pc-board thicknesses from 6.6 mm ± 0.5 mm
Distance ring 7.2 - 8: for pc-board thicknesses from 7.2 to 8 mm ± 0.5 mm

The larger support surface provided by the attached distance ring reduces the risk of probe tilting when inserting or removing the probe tip into/from the through-hole. For this reason, we recommend the use of the distance ring 7.2 - 8 even for measurements on pc-boards with thicknesses above 8 mm.

2.11.12 Sensitivity for Accepting a Measurement

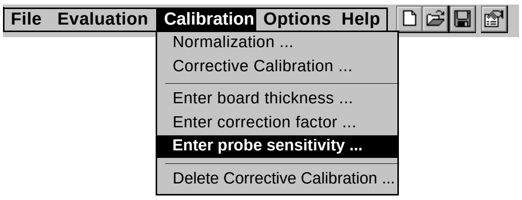
The sensitivity for accepting a measurement can be set via a particular factor if the time for accepting the measurement is too long:
Lowest sensitivity: 8, highest sensitivity: 0.5.

Default setting: 1.5

Changes to the probe sensitivity apply exclusively to the open application.

Procedure

1. Open the window for sensitivity entry:

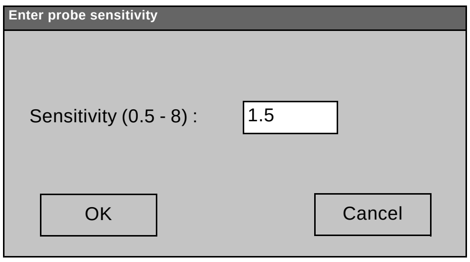


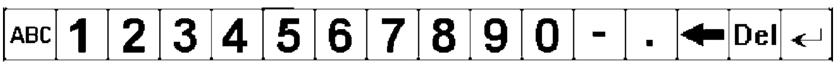
Open window
Enter probe sensitivity

Tap **Calibration** / **Enter probe sensitivity ...** on the display in succession using the stylus.

The window *Enter probe sensitivity* opens.

2. Change factor:





Window *Enter probe sensitivity*

Double-tap on the entry field (to the right of Sensitivity (0.5 - 8)). Use the entry bar at the bottom of the display, tap the numbers in succession.

Default setting: 1.5

Entry range: 0.5 to 8

3. Tap the OK button, with the stylus to confirm the entry.

Saving the entry and closing the window

2.11.13 Assembly / Replacement - Probes ESL080B and ESL080V

The ESL080... probes consist of 2 components.

Assembly

Assemble the probe according to the figure to the left.

Replacing the probe tip (= replacement measuring element)

If the probe tip is defective, only the front probe section (= replacement measuring element) needs to be replaced.

Replacement measuring element and probe receptacle are adjusted to each other and form one unit.
When replacing the replacement element, a new adjustment must be performed for the (new) replacement element and the (old) probe receptacle! A master calibration must be performed for this adjustment, .2-76

- Remove the replacement element from the probe receptacle by **pulling** it in the direction of the probe tip. There will be some resistance because a catch rim must be overcome.
- Insert the new replacement measuring element into the probe receptacle as shown in the figure.

Do not twist the replacement element in the probe receptacle! Twisting will damage the connector!

Transporting

The tips of the ESL080... model probes are very sensitive to mechanical stress.

Always ship/transport the replacement element in the supplied plastic tube!
Only this plastic tube will provide effective protection against damage when transporting the replacement element.

2.11.14 Master Calibration

The master calibration sets up a new probe characteristic for the probe. The probe characteristic forms the basis for converting the probe signal into the measurement (coating thickness value).

The probes of the type ESL080... supplied by Helmut Fischer GmbH are master calibrated for the coating/substrate material combination Cu/Iso (factory pre-calibrated). A new master calibration becomes necessary when the probe tip (= replacement measuring element) is replaced.

The master calibration is performed for the connected probe (measuring probe receptacle with inserted new replacement element).

The master calibration irrevocably alters the probe characteristic in the probe!!!

To avoid erroneous measurements, the corrective application is deleted for the open application when performing a master calibration.

Perform the master calibration carefully! It determines the accuracy for the subsequent measurements. - Measurements can never be more accurate than the master calibration!

A new master calibration irrevocably overwrites the current master calibration!!!

Required Materials/Standards/Settings

Saturation:

- Cu Reference Board (603-944) from Fischer.
  The copper quality of the Cu Reference Board 603-944 corresponds to a modern electroplating bath and is sufficient for typical practical applications.

Calibration standard(s):

- PTH Calibration Standard Board (603-982) from Fischer.
  The copper quality of the PTH Calibration Standard Board 603-982 corresponds to a modern electroplating bath and is sufficient for typical practical applications.

The electrical conductivity is temperature-dependent, so it is important that the temperature of the Cu Reference Board and the PTH Calibration Standard Board must be + 20 °C (+68 °F) during the measurements of the master calibration!

During the master calibration, the pc-board thickness is automatically set to 1.6 mm (menu **Calibration/Enter board thickness**) and the correction factor to 100 (menu **Calibration/Enter correction factor**).

Setting the "Special Menu"
for the measurement and evaluation program (MMS_CE)

- The default setting for the measurement and application program (MMS_CE) is "Standard Menu". To perform the master calibration, the setting for the measurement and evaluation program (MMS_CE) must be "Special Menu".

Procedure for switching to "Special Menu":

Open the window *Supervisor*, **Tab** *Mode*

1. Open the window *Supervisor*:
   Tap Options / Supervisor ... on the display in succession using the stylus.

   Enter password: **Tap the number 1 5 9** at the entry bar at the bottom of the display in succession using the stylus, then tap the **OK** command button.

Settings in the window *Supervisor*, **Tab** *Mode*

2. Select "Special Menu" from the one-line list box "Menu Selection".
   Tab ▼ and select the desired menu.

Save the selection and close the *Supervisor* **window**

3. Confirm the selection with **OK**.
   The *Supervisor* window closes.

The menu setting is an instrument setting that is retained even after the instrument is switched off. After the instrument is switched on again, the measurement and evaluation program (MMS_CE) will again open in the special menu.

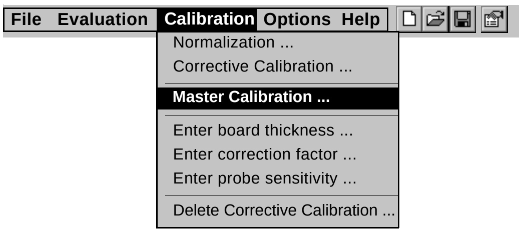
The "Special Menu" can be recognized only by the additional menu commands such as the command **Define Features ...** from the **Option** menu.

We recommend returning the program to “Standard Menu” after the master calibration has been performed to avoid erroneous operation.

Procedure for the Master Calibration

(Calling the master calibration is possible only from the “Extended Menu”, ref. previous section)

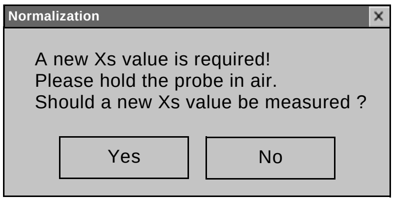
1. Calling the master calibration function:



Open window
Master Calibration

Tap **Calibration / Master Calibration ...** on the display in succession using the stylus.

2. Get "air value":

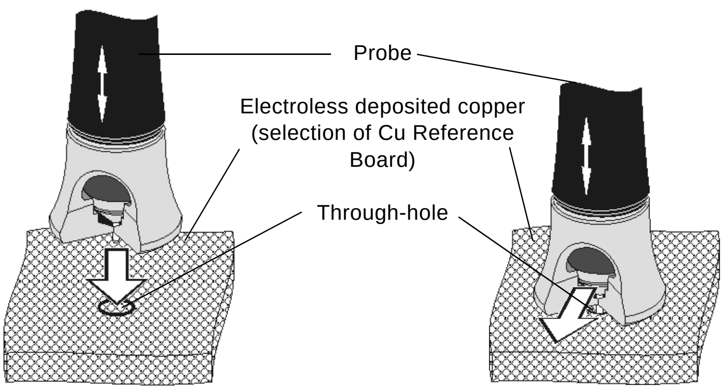


Window *Normalization*

1. Hold probe in the air. The distance to the closest object must be a minimum of 5 cm (2").
2. Tap the **Yes** button with stylus.

The window *Master Calibration* opens.

3. Measure on saturation (Cu Reference Board 603-944):



Insert the probe vertically into the through-hole. After placing the probe foot, press the probe tip **lightly** onto the hole wall in the area of the V-shaped cutout of the probe foot. Wait (about 1 to 2 seconds) until the measured value appears on the display. Then remove the probe vertically from the through-hole to avoid tilting.

Window *Master Calibration*
Tab *Normalization*

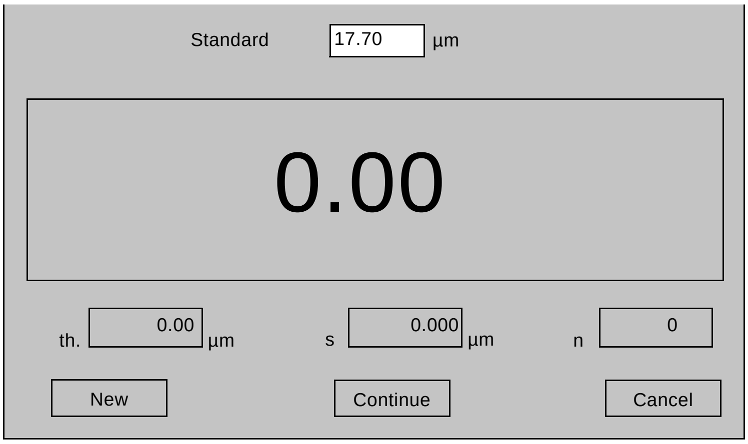
1. Insert the probe several times (5 to 10 times) in the through-hole of the Cu Reference Board.

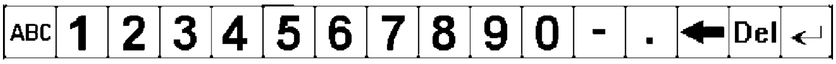
Probe ESL080V: Always measure with the attach distance ring 1,6 placed on the Cu Reference Board!

Handling of the probe beginning on page 2-71.

2. Tap **Continue** button with the stylus.

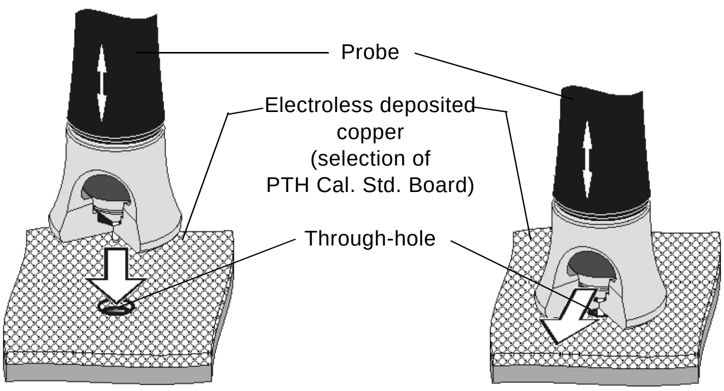
4. Measure in the through-hole 1 (to 5) of the PTH Cal. Standard Board (603-982):





Window *Master Calibration*
Tab *Standard 1 (till 5)*

1. Check the displayed thickness value (field Standard) with the thickness value of the present standard.
The displayed standard thickness does not correspond to the thickness of the present standard. In this case, enter the thickness that is specified on the present standard into the field "Standard": Double-tap on the entry field. Use the entry bar at the bottom of the display, tap the numbers in succession (Example: 1 7 . 7 for the coating thickness in the through-hole of 17.7 µm labeled on the PTH Cal. Standard Board 603-982).



Insert the probe vertically into the through-hole. After placing the probe foot, press the probe tip **lightly** onto the hole wall in the area of the V-shaped cutout of the probe foot. Wait (about 1 to 2 seconds) until the measured value appears on the display. Then remove the probe vertically from the through-hole to avoid tilting.

2. Perform 5 to 10 measurements on the PTH Cal. Standard Board (1 resp. 2).
Insert the probe several times (5 to 10 times) in the respective through-hole of the calibration board.

! **Probe ESL080V: Always measure with the attached distance ring 1.6 placed on the PTH Cal. Standard Board!**

3. Tap the **Continue** button with the stylus.

4. Perform steps **4.*1.*** to **4.*3.*** with the other standards (through-holes 2 to 5).

Then continue with step # **4.**5.

If problems occur, see Section “Trouble Shooting“ on Page 2-81.

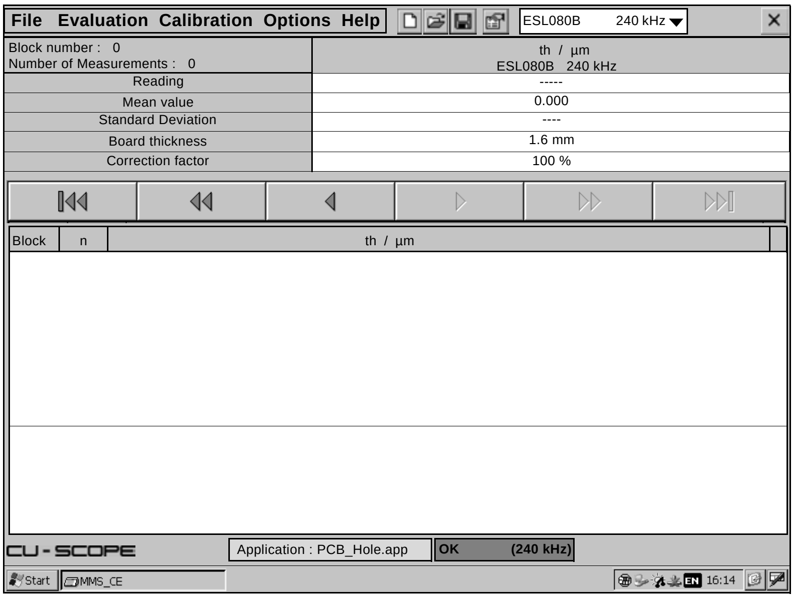
5. Tap the **Finish** button with the stylus.

The window *Master Calibration* closes.

A window opens with the message that the corrective calibration will be deleted now. Tap the **OK** button to confirm the message and close the window.

Saving the changes in the current application:

Save changes



Measuring mode Numeric Display of n application setting up with the probe ESL080B.

1. Tap the button with the stylus.

The master calibration is finished.

If applicable, return the pc-board thickness and the correction factor to their original values from before the master calibration.

See page 2-67.

PLEASE TAKE NOTE!

After the probe has been master calibrated, none of the corrective calibrations that have been performed in the applications prior to the master calibration will be correct. To be safe, delete the corrective calibrations in all of these applications. This applies also to applications that are not stored in the instrument but on a network server, external hard disk, on PC or on USB sticks. If applicable, perform a corrective calibration with the new master calibrated probe.

Trouble Shooting

Potential problems that may occur during the master calibration and their corrections.

Message	Cause / Correction
Reading outside interval! .	The coating thickness measured in the through-hole does not fit the stated nominal thickness. - Measurement performed in the wrong through-hole by mistake. - Coatings in the through-hole defective, e.g., due to heavy wear, - dirt, etc. <u>Correction</u>: Tap the control button **New** and remeasure in the correct through-hole. Use the **Intervall** button to check if the measurement within the displayed intervall.
It was not possible to calculate the parameters.	An error occurred during the master calibration. <u>Correction</u>: Redo the master calibration.

2.12 Measurements with the PHASCOPE®/DUPLEX Module

The module includes 3 measurement test methods: magnezic induction test method (DIN EN ISO 2178), amplitude sensitive eddy current test method (DIN EN ISO 2360) and the phase sensitive eddy current test method (DIN EN ISO 21968). Enables measurements of individual thicknesses of a lacquer-zinc coating system on iron or steel. The measurement of the individual thickness occurs in one step. The individual coating thicknesses of Zn and lacquer are presented next to each other on the display.

Please note for DUPLEX measurements:

- Aside from galvanically deposited zinc coatings, hot dip galvanized coatings can be measured only if there are no pronounced diffusion zones between zinc and steel.
- **Hot dip galvanized coatings with pronounced diffusion zones between zinc and steel cannot be measured!**
- For measurements with zinc alloys such as ZnNi, the measurement system must be newly adapted using a corrective calibration (with 2 standards) or even with a master calibration.

2.12.1 Duplex Probes - Selection of the Duplex or Dual Mode

For measurements with the PHASCOPE®/DUPLEX module, application memories can be set up in the so-called Duplex Mode or in the Dual Mode.

Duplex Mode

The measurement applications Lacquer/Zn/Fe (Iso/NF/Fe) and/or Lacquer/Al (Iso/NF) can be measured using this mode. The thicknesses of the individual coatings of the duplex coating (lacquer and Zn) are displayed side by side. For the measurement application Lacquer/Al, only the lacquer coating thickness is displayed, the column for the Zn coating thickness remains empty. Also, both measurement applications can be measured in one application; the probe “recognizes” the substrate material (Fe or NF) and automatically uses the appropriate measurement method. In this case, the respective corrective calibrations must be carried out in succession for the two measurement applications (e.g., a first calibration run for Lacquer/Zn/Fe, 2-86, and a second calibration run for Lacquer/Al, 2-92).

Dual Mode

The measurement applications Lacquer/Al (Iso/NF) and/or Zn/Fe (NF/FE) can be measured using this mode. In the measurement mode, only the coating thickness readings of one coating are displayed, either the lacquer or the Zn coating. Also, both measurement applications can be measured in one application; the probe “recognizes” the substrate material (Fe or NF) and automatically uses the appropriate measurement method. In this case, the respective corrective calibrations must be carried out in succession for the two measurement applications (Zn/Fe, 2-97, and Lacquer/Al, 2-92).

2.12.2 Influencing Variables Taken into Consideration

For correct measurements of the coating thickness, the instrument and the probe, together referred to as the measurement system, must “become familiar” with the specimen (part). This is done using a calibration. The influencing parameters are captured using a reference part and can then be compensated in future measurements. The calibration is preformed for the respective open Application. The correction factors determined in this step must be stored in the open Application (measuring application file).

Main variables influencing the coating thickness measurement for measurments with the PHASCOPE®/DUPLEX module (magnetic induction, amplitude and phase sensitive eddy current test method):

Coating/substrate material	Influencing variables	Mode	Corrective calibration up from page
Lacquer/Zn/Fe	● Magnetic permeability of the Fe substrate material ● Electrical conductivity of the NF coating material ● Temperature of the specimen	Duplex	2-86
Lacquer/Al	● Electrical conductivity of the NF coating material ● Temperature of the specimen	Duplex + Dual	2-92
Zn/Fe	● Magnetic permeability of the Fe substrate material	Dual	2-97

NF: Non-magnetizable, electrically conducting coatings (non-ferrous metal coatings)
NC: Insulating materials, electrically non-conducting, non-magnetizable
Fe: Magnetizable steel or iron
Al: Aluminum / Zn: Zinc

The influencing variables listed in the table can be compensated to a great extent by a corrective calibration. The corrective calibration facilitates a more precise adjustment of the factory pre-calibration stored in the probe to the properties (e.g., permeability, conductivity of the materials, geometry) of the specimen. It not only adjusts to the uncoated specimen material (called base) and/or the coating material (called saturation), but also to at least one coating thickness value (coated substrate material). The coating thickness value is taken from a coated reference part with a known coating thickness, a calibration standard. However, a foil (calibration foil) with a known thickness that is placed on an uncoated substrate material may be a calibration standard as well. Materials and shape of the base, saturation and calibration standard (coated part from the production) must correspond to those of the specimen to be measured. The same applies to the position of the measured areas. The position of the measurement spot on base, saturation and on the calibration standard must correspond to that on the subsequent test specimens, i.e., the test parts from the production (same distance to edge/borehole, same curvature radius, etc.). The corrective calibration must be performed using one calibration standard. We recommend using 2 calibration standards with different coating thicknesses for the corrective calibration.

In general, the material properties (permeability, electrical conductivity) of the specimen will differ significantly from those taken into account in the master characteristic of the probe. It is, therefore, **absolutely essential to perform the corrective calibration using reference parts** (base, saturation, calibration standards) **from one's own production!** It is, therefore, necessary that the user produces calibration standards (base, saturation and coated calibration standards) from his own production.

The corrective calibration applies only to the open application, or to all applications linked to the open one and the coating thickness ranges of the used standards, respectively. This means, an accurate measurement with great trueness (accuracy) is possible only in this range. A new corrective calibration (possibly in a new and different application) must be performed for measurements outside of this coating thickness range. For example, the coating thicknesses of the calibration standards should be about 6 and 15 µm if the Zn thickness range to be measured is between 6 and 15 µm. If the Zn thickness range to be measured is expanded to about 25 µm, then a new corrective calibration must be performed using calibration standards with suitable thicknesses (for example, 6 and 25 µm).

Please note for DUPLEX measurements:

- For measurements with zinc alloys such as ZnNi, the measurement system must be newly adapted using a corrective calibration (with 2 standards) or even with a master calibration.
- As a rule, the Fe sheets from different batches will have different permeabilities. This means that the measurement system must be adapted to the changed material properties before making measurements on a new batch. As a rule, a normalization should be sufficient if the zinc bath is not changed (Call: Calibration/Normalization, measure 5 - 10 times on the uncoated substrate material of the new batch). If the zinc bath has changed as well, a corrective calibration should be performed. For this purpose, base, saturation and calibration standards must be set up from the new batch.

As a standard, the measuring system is pre-calibrated for measurements on the following coating/substrate material combinations: Lacquer/Zn/Fe, Lacquer/Al and Zn/Fe.
The measuring system must be master-calibrated for other coating/substrate material combinations. Please contact your authorized Fischer distributor or Helmut Fischer GmbH directly for appropriate master calibration standards sets. www.helmut-fischer.com

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2.12.3 Corrective Calibration - Duplex Coatings (Lacquer/Zn/Fe)

A corrective calibration for a duplex coating system (Lacquer/Zn/Fe) can performd only for an application set up with the Duplex-Mode.

A corrective calibration should always be performed under conditions that are comparable to those of the specimen!
Same substrate material for the calibration standard and for the specimen, same curvature, same position on the measurement area, etc.!

Perform the corrective calibration carefully! It determines the accuracy for the subsequent measurements. - Measurements can never be more accurate than the corrective calibration!

The fact that the electrical conductivity of the Zn coating varies depending on the bath composition must be taken into account when performing a corrective calibration. To this end, the Zn coatings of the calibration standards must come from the same baths as the Zn coatings of the specimens. The electrical conductivity is temperature-dependent. This can cause measurement errors if the temperature of the reference parts (base, saturation and calibration standards) during the corrective calibration differs significantly from the temperature of the specimens.

Required materials/standards (from own production):

- Saturation: Reference part, only of the Zn coating material with a thickness that is greater than the max. measurable thickness (> 150 µm). Only Zn coating material without lacquer coating. Mark the measurement area on the reference part at the location where it will be on the actual specimen.

Use the supplied Zn saturation part (602-663) for the measurement on saturation only if there is no possibility of setting up a Zn saturation part from the Zn bath in use.

- Base: Uncoated specimen or material that corresponds to the uncoated specimen in material properties and geometry. Mark the measurement area on the reference part on the location where it will be on the actual specimen.

To measure on base (= substrate material without coatings), do not use the supplied metal plate (NF/FE)! It should be used for a function check only!

- Calibration standards: Zn coated parts **without** lacquer coating from the production with Fe substrate, Zn coating materials and geometry that correspond to those of the specimen. The thickness of the Zn coating material should be in the range of the coating thickness to be measured. Mark the measurement area on the reference part on the location where it will be on the actual specimen.

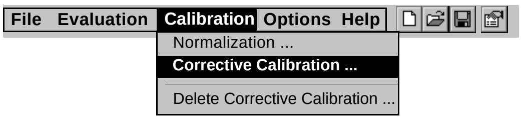
Information on creating in-house calibration standards can be found beginning on page 2-101.

- Calibration foils: Synthetic or Copper-Beryllium foils supplied with the probe or having thicknesses that delimit the coating thickness range to be measured. On the foils, the measurement area is marked by a circle.

Please contact your authorized Fischer distributor or Helmut Fischer GmbH directly for calibration foils with appropriate thicknesses. www.helmut-fischer.com

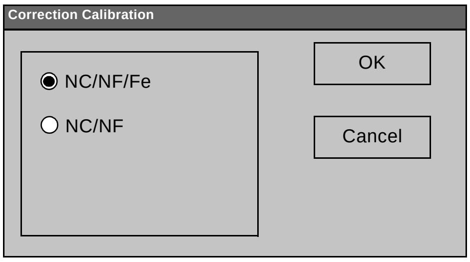
Procedure:

1. Calling the corrective calibration function:



Tap **Calibration / Corrective Calibration ...** on the display in succession using the stylus.

2. Select the coating/substrate material combination:

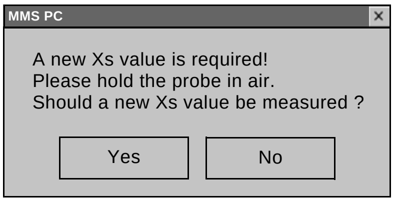


NC/NF/Fe: Lacquer/Zn/Fe Duplex coating on ferrous substrate material

NC/NF: Lacquer/Al Electrical non-conductive coating material on non-ferrous and non-magnetizable substrate material

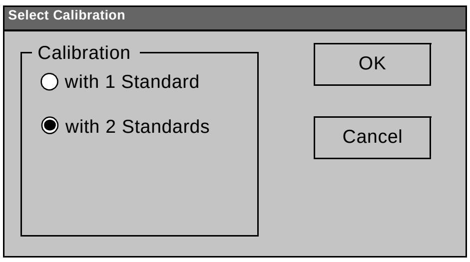
1. Tap "**NC/NF/Fe**" for the duplex coating application.
2. Tap the **OK** button with the stylus to confirm the selection.

3. Get "air value":



1. Hold probe in the air. The distance to the closest object must be a minimum of 5 cm (2").
2. Tap the **Yes** button with stylus.

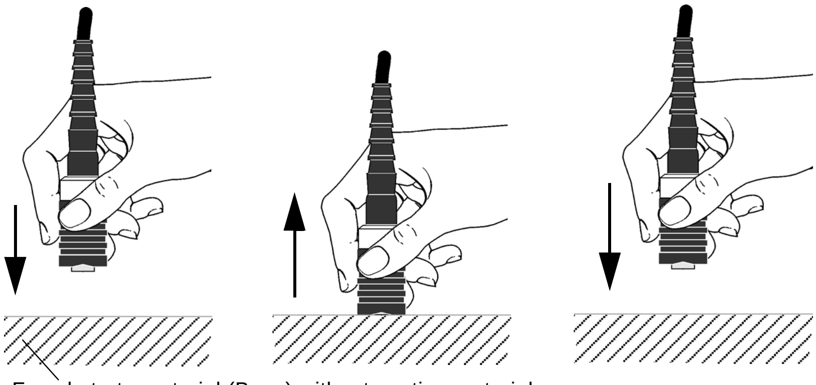
4. Select the number of the coated standards used for the corrective calibration:



1. Tap "**with 2 Standards**" to get the best measurement accuracy for the desired measurement range.
2. Tap the **OK** button with the stylus to confirm the selection.

The window *Correction Calibration - NC/NF/Fe* opens.

5. Measure on uncoated Fe (substrate material adjustment)



Fe substrate material (Base) without coating materials

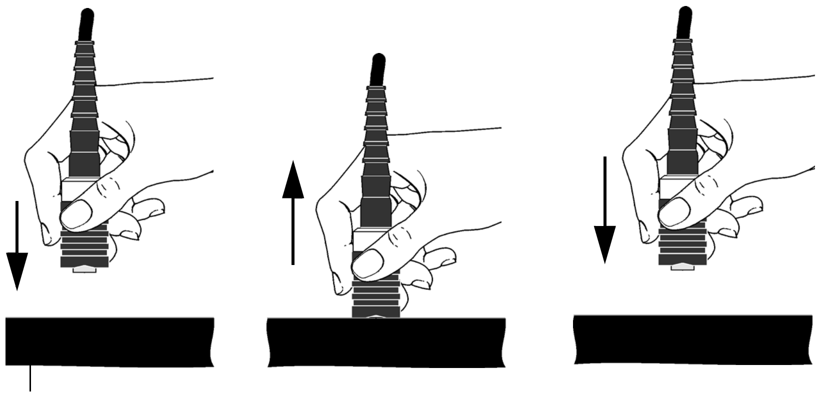
Place the probe on the marked measurement area.

Measurements with probe see Section "Making Measurements", page 2-13.

Window *Correction Calibration - NC/NF/Fe*
Tap *Normalization Fe:*

1. Perform 5 to 10 measurements on the uncoated substrate material (=Base, reference part **without** coating materials). For this purpose, place the probe on the marked measurement area.
2. Tap **Continue** button with the stylus.

6. Measure on Zn (coating material adjustment)



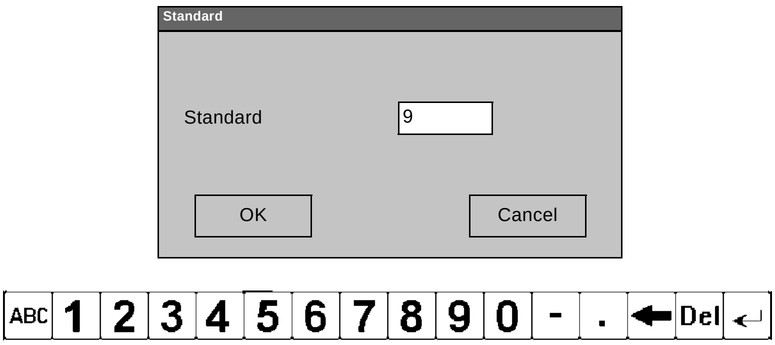
Metal coating material without the lacquer coating (Zn)

Place the probe on the marked measurement area.

Window *Correction Calibration - NC/NF/Fe*
Tap *Normalization NF:*

1. Perform 5 to 10 measurements on the plain coating material (=saturation, only Zn coating material). For this purpose, place the probe on the marked measurement area.
2. Tap **Continue** button with the stylus.

7. Measurement with calibration foil on uncoated Fe

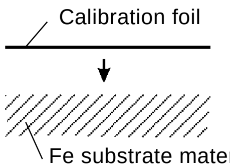


Window *Correction Calibration - NC/NF/Fe*
Tap *Standard NC/Fe (1 or 2)*:

1. Check the displayed thickness value with the thickness value of the calibration foil. If the thickness values do not correspond, enter the thickness that is specified on the calibration foil into the

field "**Stand-ard**": Tap on the **Standard** button with the stylus to open the entry window. Tap on the white entry field. Use the entry bar at the bottom of the display, tap the numbers in succession (Example: 9 . 1 for the foil thickness of 9.1 µm labeled on calibration foil). Use the **OK** button to confirm the entry.

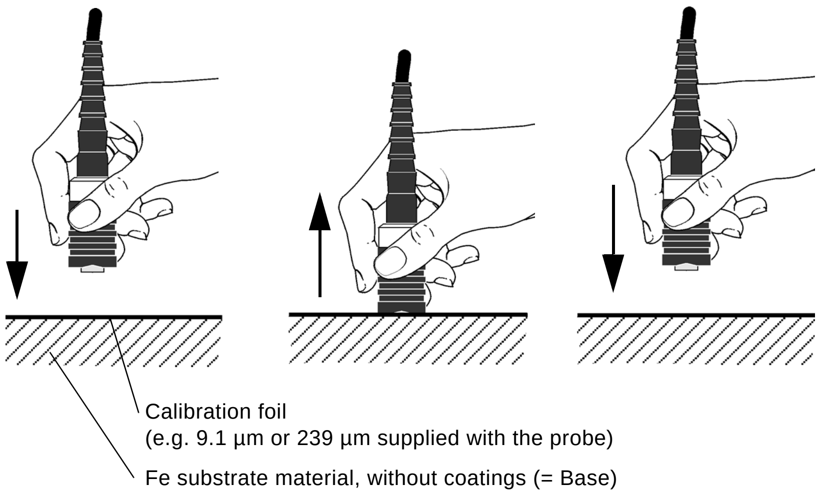
2. **Place the calibration foil on the uncoated substrate material** (e.g. 9.1 µm calibration foil supplied with the probe).



The circle on the calibration foil must lie on the marked measurement area of the uncoated substrate material.

Only one foil at a time may be placed on the reference part! When using 2 standards (calibration foils): Remove calibration foil 1 for the second run and only then place calibration foil 2.

3. Perform 5 to 10 measurements on the calibration foil (standard 1 or 2). For this purpose, place the probe within the respective circle on the calibration foil.



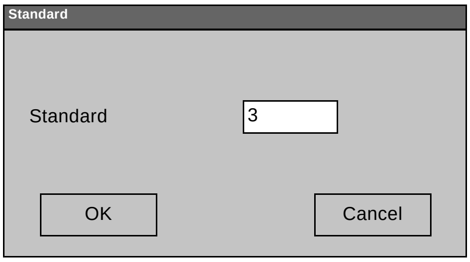
Place the probe within the circle on the calibration foil.

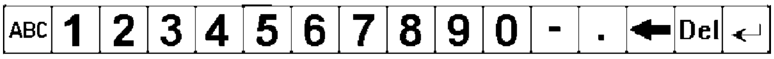
4. Tap **Continue** button with the stylus.

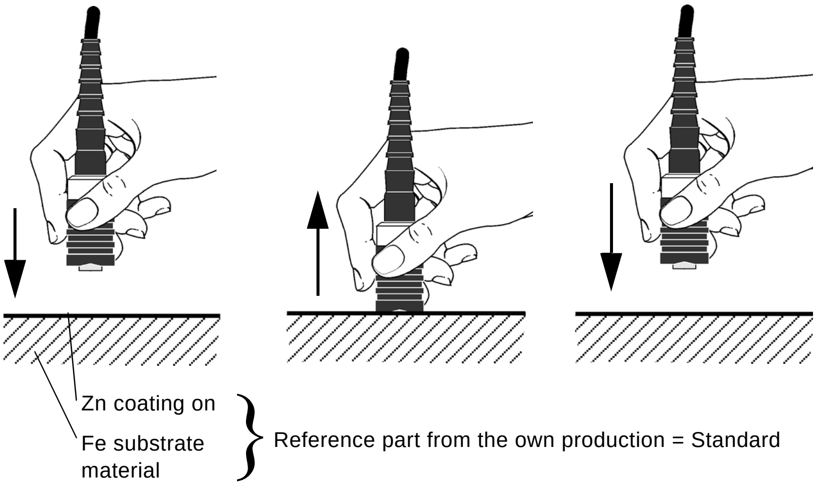
For the corrective calibration with only one standard continue with section # 7.*8*.

5. Perform steps 7.*1.* to 7.*4.* with the second calibration foil (standard 2, e.g. 239 µm supplied with the probe). Then continue with section # 7.*8* .

8. Measurement on Zn coated reference part (without lacquer coating)







Place the probe on the marked measurement area.

Window *Correction Calibration - NC/NF/Fe*
Tap *Standard NF/Fe (1 or 2)*:

1. Check the displayed thickness value with the Zn thickness value of the present standard. If the thickness values do not correspond enter the thickness that is specified on the present standard into the field "**Standard**": Tap on the **Standard** button with the stylus to open the entry window. Tap on the white entry field. Use the entry bar at the bottom of the display, tap the numbers in succession.

2. Perform 5 to 10 measurements on the standard 1 (or 2).For this purpose, place the probe on the marked measurement area.

3. Tap **Continue** button with the stylus.

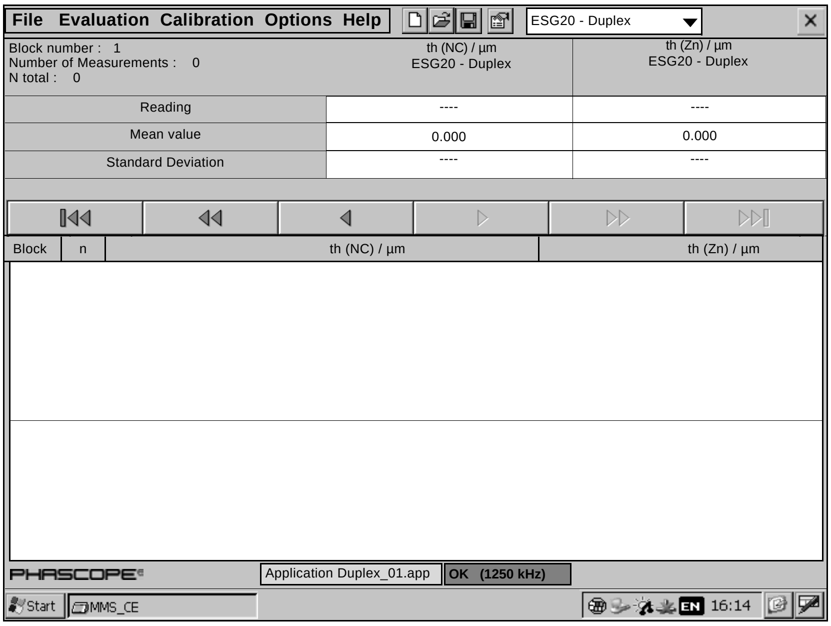
For the corrective calibration with only one standard, or after the measurement on the second standard continue with step # **8.***5*.

4. Perform steps **8.***1.* to **8.***2.* with the second standard.

5. Tap the **Finish** button with the stylus.

The window *Correction Calibration* closes.

9. Saving the parameters of the corrective calibration in the current application:



Display of reading in Duplex Mode.

1. Tap the button with the stylus.

The corrective calibration is finished and has been stored in the open application. Thus, for this application, a new corrective calibration is not required before every measurement.

Please note:
As a rule, the Fe sheets from different batches will have different permeabilities. This means that the measurement system must be adapted to the changed material properties before making measurements on a new batch. As a rule, a normalization should be sufficient if the zinc bath is not changed (Call: Calibration/Normalization, measure 5 - 10 times on the uncoated substrate material of the new batch). If the zinc bath has changed as well, a corrective calibration should be performed. For this purpose, base, saturation and calibration standards must be set up from the new batch.

2.12.4 Corrective Calibration - Lacquer/Al (Duplex and Dual Mode)

(Electrically non-conducting coating on non-ferrous metal substrate, NC/NF)

Necessary:

- If the trueness is not met when making measurements on customer reference parts (customer standards), a corrective calibration should be performed.

A corrective calibration should always be performed under conditions that are comparable to those of the specimen!
Same substrate material for the calibration standard and for the specimen, same curvature, same position of the measurement area, etc.!

Perform the corrective calibration carefully! It determines the accuracy for the subsequent measurements. - Measurements can never be more accurate than the corrective calibration!

Required materials/standards:

- Base: Uncoated specimen or material (**from one's own set-up**) that corresponds to the uncoated specimen in material properties and geometry. Mark the measurement area on the reference part at the location where it will be on the actual specimen.

To measure on base (= substrate material without coatings), do not use the supplied metal plate (ISO/NF)! It should be used for a function check only!

- Calibration foils: Synthetic or Copper-Beryllium foils supplied with the probe or with thicknesses that delimit the coating thickness range to be measured. On the foil, the measurement area is marked by a circle.

Please contact your authorized Fischer distributor or Helmut Fischer GmbH directly for calibration foils with appropriate thicknesses. www.helmut-fischer.com

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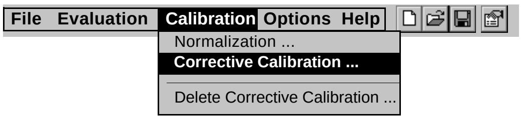
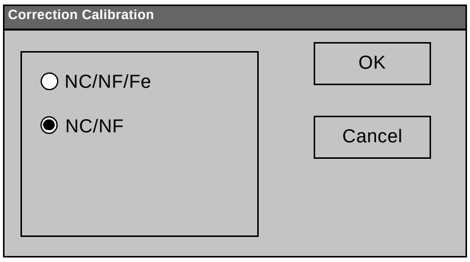
Procedure:

1. Calling the corrective calibration function:



Tap **Calibration / Corrective Calibration ...** on the display in succession using the stylus.

2. Select the coating/substrate material combination:



NC/NF/Fe: Lacquer/Zn/Fe (Duplex Mode)
Duplex coating on ferrous substrate material

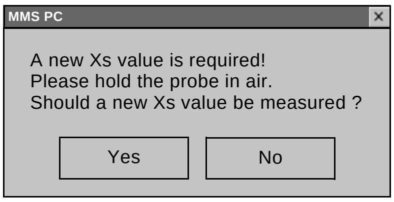
or

NF/Fe: Zn/Fe (Dual Mode)
Non-ferrous coating material on ferrous substrate material.

NC/NF: Lacquer/Al (Duplex and Dual Mode)
Electrically non-conducting coating material on non-ferrous and non-magnetizable substrate material

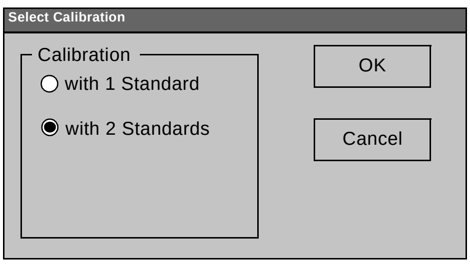
1. Tap "**NC/NF**" with the stylus for the lacquer on Aluminum application.
2. Tap the **OK** button with the stylus to confirm the selection.

3. Get "air value":



1. Hold probe in the air. The distance to the closest object must be a minimum of 5 cm (2").
2. Tap the **Yes** button with stylus.

4. Select the number of the calibration foils used for the corrective calibration:

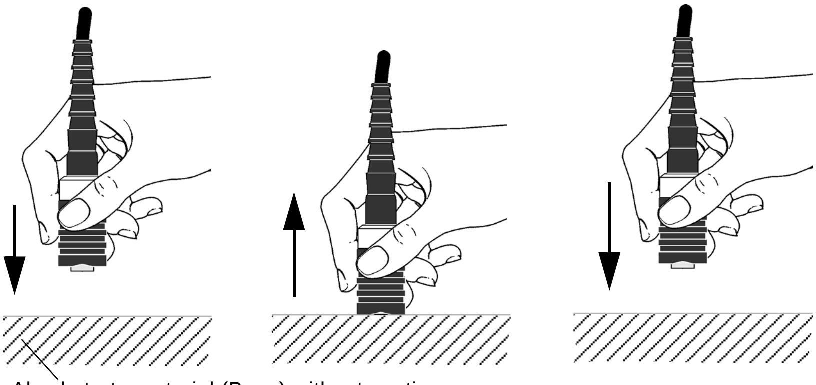


1. Tap "**with 2 Standards**" to get the best measurement accuracy for the desired measurement range.
2. Tap the **OK** button with the stylus to confirm the selection.

   The window *Correction*

Calibration - NC/NF opens.

5. Measure on uncoated Al(substrate material adjustment)



Al substrate material (Base) without coating

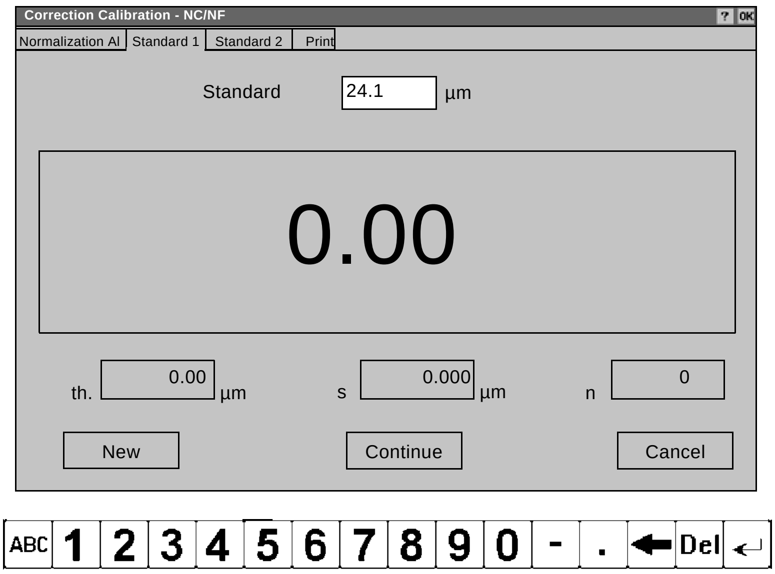
Place the probe on the marked measurement area.

Measurements with probe see Section "Making Measurements", page 2-11.

Window *Correction Calibration - NC/NF*
Tap *Normalization Al:*

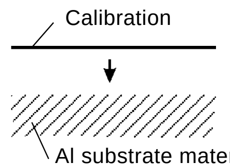
1. Perform 5 to 10 measurements on the uncoated substrate material (=Base, reference part **without** coating materials). For this purpose, place the probe on the respective marked measurement area.
2. Tap **Continue** button with the stylus.

6. Measurement with calibration foil on uncoated Al



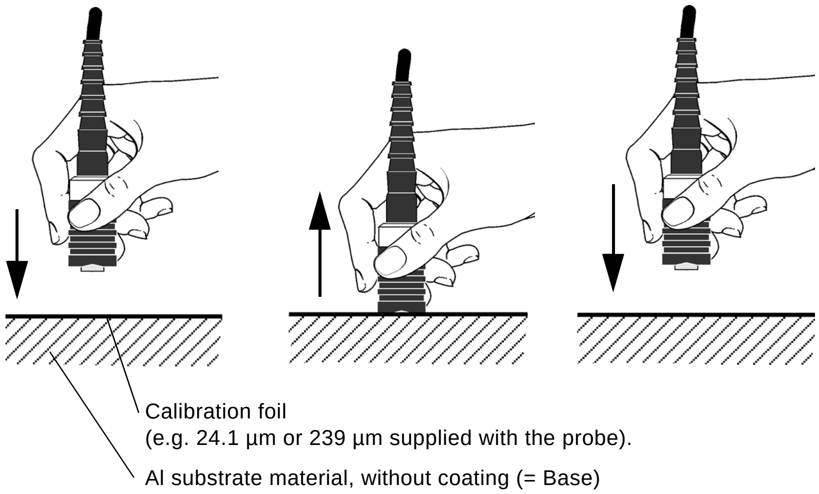
Window *Correction Calibration - NC/NF*
Tap *Standard 1 (2)*:

1. Check the displayed thickness value with the thickness value of the calibration foil. If the thickness values do not correspond, enter the thickness that is specified on the calibration foil into the field "**Stand-ard**": **Double**-tap on the white entry field with the stylus. Use the entry bar at the bottom of the display, tap the numbers in succession (Example: 2 4 . 1 for the foil thickness of 24.1 µm labeled on calibration foil).



T**he circle on the calibration foil must lie on the marked measurement area of the uncoated substrate material.**

Only one foil at a time may be placed on the reference part! When using 2 standards (calibration foils): Remove calibration foil 1 for the second run and only then place calibration foil 2.



Place the probe within the circle on the calibration foil.

2. Place the calibration foil on the uncoated substrate material (e.g. 24.1 µm calibration foil supplied with the probe).

3. Perform 5 to 10 measurements on the calibration foil (standard 1 or 2). For this purpose, place the probe within the respective circle on the calibration foil.

For the corrective calibration with only one calibration foil, or after the measurement on the second calibration foil continue with step # **6.***6.*

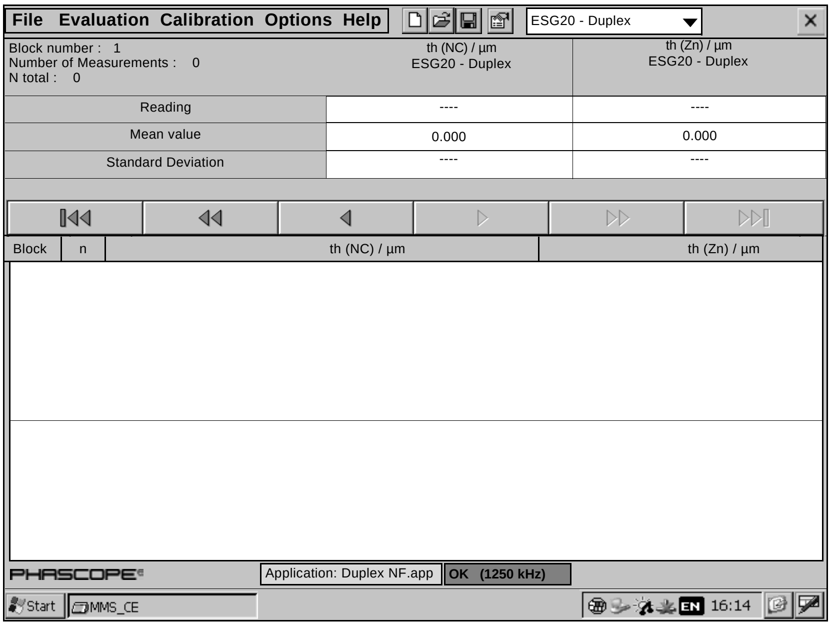
4. Tap **Continue** button with the stylus.

5. Perform steps **6.***1.* to **6.***3.* with the second calibration foil (standard 2, e.g. 239 µm supplied with the probe). Then continue with step # **6.***6.*

6. Tap the **Finish** button with the stylus.

The window *Correction Calibration* closes.

7. Saving the parameters of the corrective calibration in the current application:



Display of reading in Duplex Mode.

1. Tap the button  with the stylus.

The corrective calibration is finished and has been stored in the open application. Thus, for this application, a new corrective calibration is not required before every measurement.

2.12.5 Corrective Calibration - Zn/Fe (Dual Mode)

A corrective calibration for Zn coatings on ferromagnetic base material (Zn/Fe) can performd only for an application set up with the Dual-Mode.

A corrective calibration should always be performed under conditions that are comparable to those of the specimen!
Same substrate material for the calibration standard and for the specimen, same curvature, same position on the measurement area, etc.!

Perform the corrective calibration carefully! It determines the accuracy for the subsequent measurements. - Measurements can never be more accurate than the corrective calibration!

Required materials/standards:

- Base: Uncoated specimen or material (**from one's own set-up**) that corresponds to the uncoated specimen in material properties and geometry. Mark the measurement area on the reference part at the location where it will be on the actual specimen.

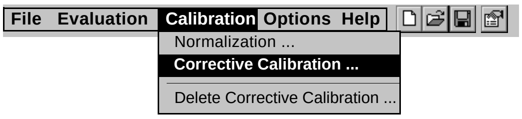
To measure on base (= substrate material without coatings), do not use the supplied metal plate (NF/FE)! It should be used for a function check only!

- Calibration foils: Synthetic or Copper-Beryllium foils supplied with the probe or with thicknesses that delimit the coating thickness range to be measured. On the foil, the measurement area is marked by a circle.

Please contact your authorized Fischer distributor or Helmut Fischer GmbH directly for calibration foils with appropriate thicknesses. www.helmut-fischer.com

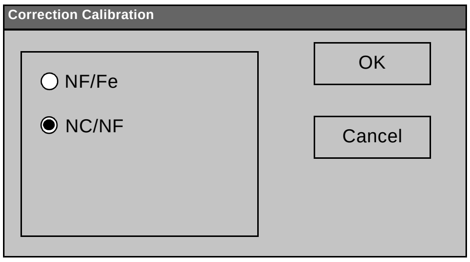
Procedure:

1. Calling the corrective calibration function:



Tap **Calibration / Corrective Calibration ...** on the display in succession using the stylus.

2. Select the coating/substrate material combination:

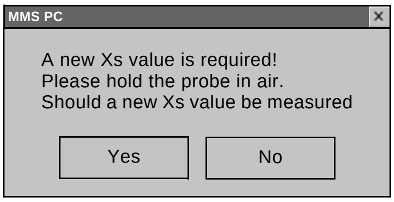


NF/Fe: Zn/Fe
Non-ferrous coating material on ferrous substrate material.

NC/NF:
Electrically non-conducting coating material on non-ferrous and non-magnetizable substrate material

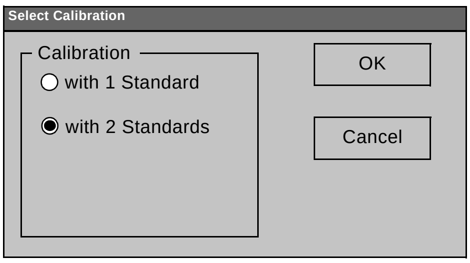
1. Tap "**NF/Fe**" with the stylus for the Zn on ferrous metal application.
2. Tap the **OK** button with the stylus to confirm the selection.

3. Get "air value":



1. Hold probe in the air. The distance to the closest object must be a minimum of 5 cm (2").
2. Tap the **Yes** button with stylus.

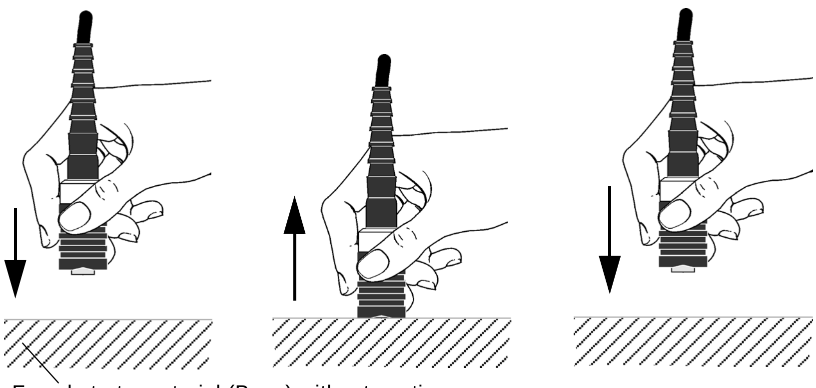
4. Select the number of the calibration foils used for the corrective calibration:



1. Tap "**with 2 Standards**" to get the best measurement accuracy for the desired measurement range.
2. Tap the **OK** button with the stylus to confirm the selection.

The window *Correction Calibration - NF/Fe* opens.

5. Measure on uncoated Fe (substrate material adjustment)



Fe substrate material (Base) without coating

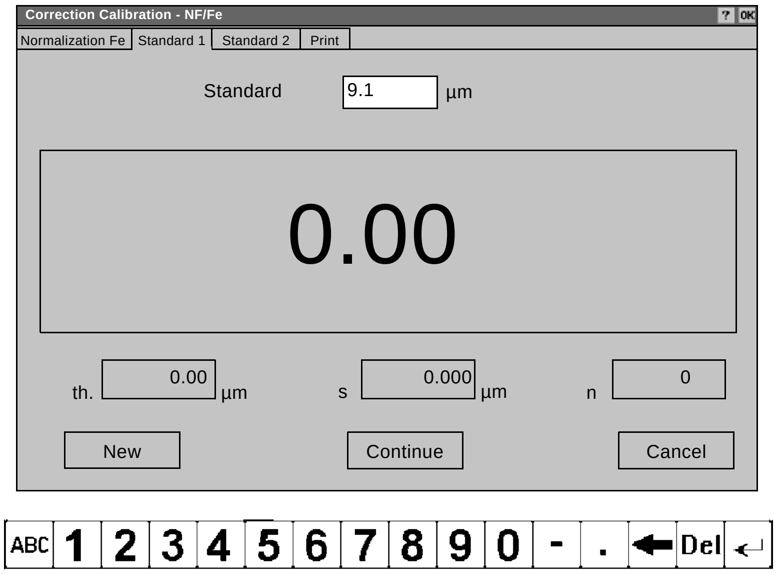
Place the probe on the marked measurement area.

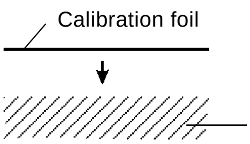
Measurements with probe see Section "Making Measurements", page 2-11.

Window *Correction Calibration - NF/Fe*
Tap *Normalization Fe:*

1. Perform 5 to 10 measurements on the uncoated substrate material (=BASE, Fe reference part **without** coating materials). For this purpose, place the probe on the respective marked measurement area.
2. Tap **Continue** button with the stylus.

6. Measurement with calibration foil on uncoated Fe



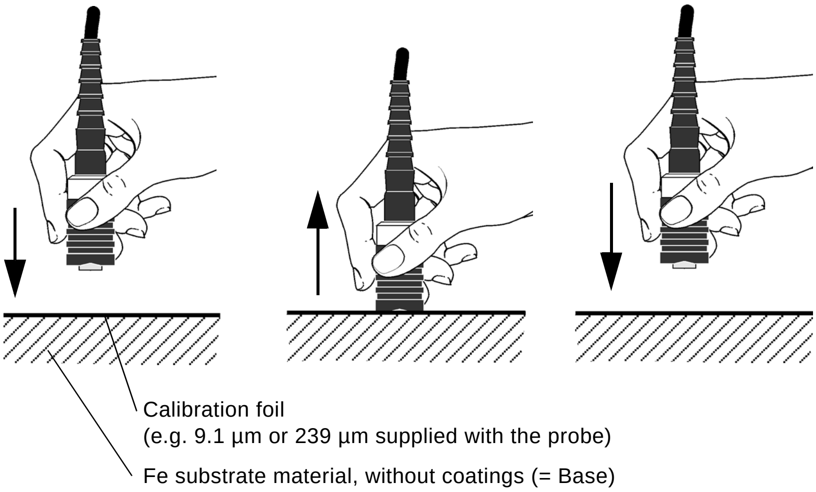


The circle on the calibration foil must lie on the marked measurement area of the uncoated substrate material.

Only one foil at a time may be placed on the reference part! When using 2 standards (calibration foils): Remove calibration foil 1 for the second run and only then place calibration foil 2.

Window *Correction Calibration - NF/Fe*
Tap *Standard 1 (2)*:

1. Check the displayed thickness value with the thickness value of the calibration foil. If the thickness values do not correspond, enter the thickness that is specified on the calibration foil into the field "**Stand-ard**": **Double-**tap on the white entry field with the stylus. Use the entry bar at the bottom of the display, tap the numbers in succession (Example: 9 . 1 for the foil thickness of 9.1 µm labeled on calibration foil).
2. Place the calibration foil on the uncoated substrate material (e.g. 9.1 µm calibration foil supplied with the probe).



Place the probe within the circle on the calibration foil.

Perform 5 to 10 measurements on the calibration foil (standard 1 or 2). For this purpose, place the probe within the respective circle on the calibration foil.

For the corrective calibration with only one calibration foil, or after the measurement on the second calibration foil continue with step # **6.***6.*

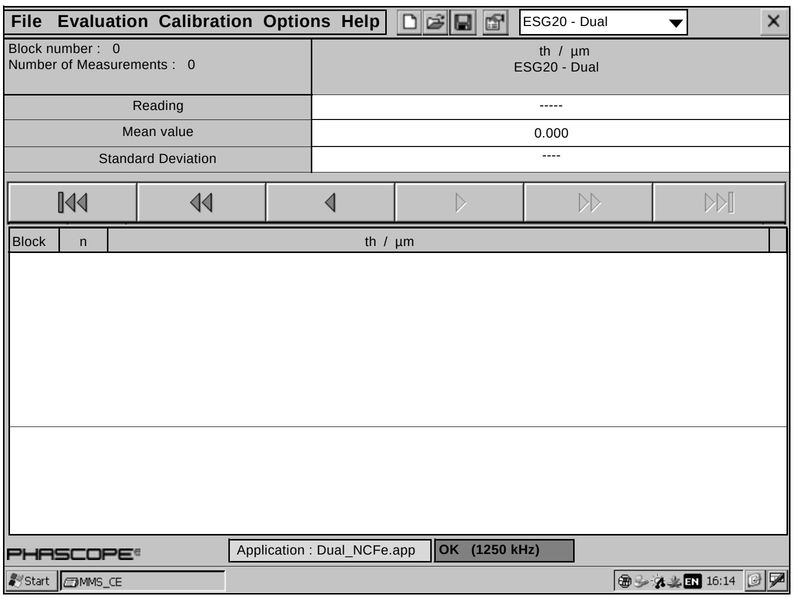
3. Tap **Continue** button with the stylus.

4. Perform steps **6.***1.* to **6.***3.* with the second calibration foil (standard 2, e.g. 239 µm supplied with the probe). Then continue with step # **6.**6.

5. Tap the **Finish** button with the stylus.

The window *Correction Calibration* closes.

7. Saving the parameters of the corrective calibration in the current application:



Display of reading in dual mode.

1. Tap the button  with the stylus.

The corrective calibration is finished and has been stored in the open application. Thus, for this application, a new corrective calibration is not required before every measurement.

2.12.6 Preparing Zn Calibration Standards

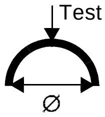
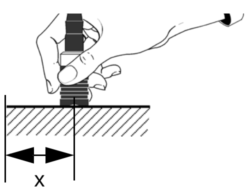
The measurement signal is dependent on the coating thickness and also on the electrical conductivity and/or the permeability of the coating and substrate materials. A calibration standard must be prepared to take these material properties into account. Using this calibration standard in a corrective calibration, the measuring system can then be adjusted to the properties of the specimen.

A specimen is taken from the production to prepare a calibration standard. For zinc measurements, parts from a bath with the same type of electrolyte (acidic, alkaline cyanide or cyanide-free), because the conductivity of the zinc coating is defined by the electrolyte.

The specimen must exhibit a uniform coating thickness distribution in order to assign a coating thickness value to this specimen. Measurements are made at several locations of the specimen to determine the coating thickness distribution. Because only the coating thickness fluctuations are of interest and not the absolute value, even an instrument (MMS® PC2) that has not yet undergone final calibration can be used. The coating thickness distribution can now be determined based on the measurement fluctuations (standard deviation). Once a specimen with a uniform coating thickness distribution (low standard deviation) has been found from the production, the (absolute) coating thicknesses are then measured using a different measuring method (e.g., coulometric or x-ray fluorescence method). Based on the uniform coating thickness distribution, the mean value from these measurements specifies the coating thickness value for the specimen. By assigning a coating thickness value, the specimen becomes a calibration standard. A measurement spot with the assigned thickness value, and where the measurements will take place during the corrective calibration, must be marked on the calibration standard.

2.12.7 Probe Specifications

Probe type	ESG20		
Coating/substrate material	Lacquer/Zn/Fe (NC/NF/Fe)	Lacquer/Al (NC/NF)	Zn/Fe (NF/Fe)
Measurement range	Lacquer: 2 ... 500 µm [0.08 ... 20 mils] Electroplated Zn coating: 2 ... 100 µm [0.08 ... 4 mils]	5 ... 2000 µm [0.2 ... 80 mils]	2 ... 600 µm [0.08 ... 24 mils]
*Repeatability precision referenced to Fischer Standards	Lacquer: 2 ... 100 µm: 0.5 µm 100 ... 500 µm: ≤ 0.5 % of reading [0.08 ... 4 mils: 0.02 mils] [4 ... 20 mils: ≤ 0.5 % of reading] Electroplated Zn coating: 2 ... 30 µm: 0.1 µm 30 ... 100 µm: ≤ 0.3 % of reading [0.08 ... 1.2 mils: 0.004 mils] [1.2 ... 4 mils: ≤ 0.3 % of reading]	5 ... 100 µm: 0.5 µm 100 ... 2000 µm: ≤0.5 % of reading [0.2 ... 4 mils: 0.02 mils] [4 ... 80 mils: ≤ 0.5 % of reading]	5 ... 100 µm: 0.5 µm 100 ... 600 µm: ≤0.5 % of reading [0.2 ... 4 mils: 0.02 mils] [4 ... 24 mils: ≤ 0.5 % of reading]
*Trueness referenced to Fischer Standards	Lacquer on Zn coating thicknesses till 30 µm [1.2 mils]: 2 ... 100 µm: ± 1 µm 100 ... 500 µm: ≤ 1 % of reading [0.08 ... 4 mils: ± 0.04 mils] [4 ... 20 mils: ≤ 1 % of reading] Lacquer on Zn coating thicknesses up to 30 µm [1.2 mils]: 2 ... 100 µm: ± 2 µm 100 ... 500 µm: ≤ 2 % of reading [0.08 ... 4 mils: ± 0.08 mils] [4 ... 20 mils: ≤ 2 % of reading] Electroplated Zn coating: 2 ... 30 µm: ± 0.5 µm 30 ... 100 µm: ± 1 µm [0.08 ... 1.2 mils: ± 0.02 mils] [1.2 ... 4 mils: ± 0.04 mils]	5 ... 100 µm: ± 2 µm 100 ... 2000 µm: ≤ 2 % of reading [0.2 ... 4 mils: ± 0.08 mils] [4 ... 80 mils: ≤ 2 % of reading]	2 ... 100 µm: ± 1 µm 100 ... 400 µm: ±1 % of reading 400 ... 600 µm: ≤ 2 % of reading [0.08 ... 4 mils: ± 0.02 mils] [4 ... 16 mils: ± 1 % of reading] [16 ... 24 mils: ≤ 2 % of reading]
Probe tip diameter	1.5 mm [0.06"]		
Probe tip material	PVD		

Probe type	ESG20		
Coating/substrate material	Lacquer/Zn/Fe (NC/NF/Fe)	Lacquer/Al (NC/NF)	Zn/Fe (NF/Fe)
*  Ø for ≥10 % measurement deviation at the master calibration on flat surface.	⌀ ≤ 22 mm [0.866"] + 10 % measurement deviation for lacquer coating thickness of 75 µm [3 mils] - 4.5 % measurement deviation for Zn coating thickness of 21 µm [0.84 mils] ⌀ ≤ 10 mm [0.4"] +22 % measurment deviation for lacquer coating thickness of 75 µm [3 mils] -10 % measurement deviation for Zn coating thicjness of 21 µm [0.84 mils]	⌀ ≤ 385 mm [15.16"] at 100 µm [4 mils] lacquer coating thickness	⌀ ≤ 16 mm [0.63"] at 100 µm [4 mils] Zn coating thickness
*Test area diameter for error ≥ 10 %	⌀ ≤ 10 mm [0.4"]		
 * Measurement deviation for edge distance x	X = 1 mm [0.04"] Measurement deviation ... ... for 75 µm lacquer thickness: + 21 % ... for 21 µm Zn thickness: -9 % X = 2 mm [0.08"] Measurement deviation ... ... for 75 µm lacquer thickness: + 10 % ... for 21 µm Zn thickness: -4 %	X ≤ 5 mm [0.2"] Measurement deviation for 100 µm lacquer thickness: ≥ 10 %	X = 1 mm [0.04"] Measurement deviation for 100 µm lacquer thickness: < 5 %
*Substrate material thickness for error ≥ 10 %	≤ 0.3 mm [12 mils] for 75 µm [3 mils] lacquer thickness	≤ 0.2 mm [8 mils] for 100 µm [4 mils] lacquer thickness	≤ 0.33 mm [13.2 mils] for 100 µm [4 mils] Zn thickness
*Coating thickness deviations for changes in the electr. conductivity of the Al material in a range of 30 to 100 %IACS.	-	≤ 3 % for lacquer thicknesses ≥ 100 µm [4 mils]	-
*Coating thickness deviations for the influence of the permeability of the Fe material for FN > 115.	-	-	≥ 10 % for 100 µm [4 mils] Zn thickness
Probe length	120 mm [4.72"]		
Probe diameter	19.5 mm [0.768"]		
Probe/measurement frequency	1250 kHz		
Master Calibration (application)	Specimen with flat, smooth surface		
Measurement methods	Magnetic induction test method according to ISO 2178 Phase-sensitive eddy current test method according to ISO 21968 Amplitude-sensitive eddy current test method according to ISO 2360		

* The specifications only be valid for probes master calibrated together with the used instrument.

2.13 Measurements with the SR-SCOPE® Module

The module SR-SCOPE® includes the resistance test method. The ERCU probe operates according to the micro-resistance method (DIN EN 14571) and is ideally suited to measure the copper thickness of laminates and multi-layers. Underlying Cu coatings does not influence the measurement result, even if the interim Epoxy layer has a thickness of only a few micrometers.

As a standard, the ERCU probe models measure galvanic deposited copper coating thicknesses. Thickness measurements of chemically deposited copper coatings needs a special probe type.

Enter the Current Temperature of the Specimen 2-106
Making Measurements 2-111
Technical Data of the ERCU Probe Model 2-113

2.13.1 Influencing Variables Taken into Consideration

For correct measurements of the coating thickness, the instrument and the probe, together referred to as the measurement system, must “become familiar” with the specimen (part). This is done using a calibration. The influencing parameters are captured using a reference part and can then be compensated in future measurements. The calibration is preformed for the respective open Application. The correction factors determined in this step must be stored in the open Application (measuring application file).

The main variables influencing the coating thickness measurement using the ERCU probe type are:

- Temperature

The temperature of the specimen is a significant influencing factor. The physical correlation between the temperature of the specimen and the coating thickness is shown in the following equation:

$$th_{20°C} = th_{meas} * [1 + \alpha_{Cu} (T - 20 °C)]$$

where:
$th_{20°C}$: Cu coating thickness referenced to 20 °C (68 °F)
th_{meas}: measured Cu coating thickness at current specimen temperature
T: current temperature of the specimen
α: temperature coefficient of Cu; α_{Cu} = 0.0039 1/K

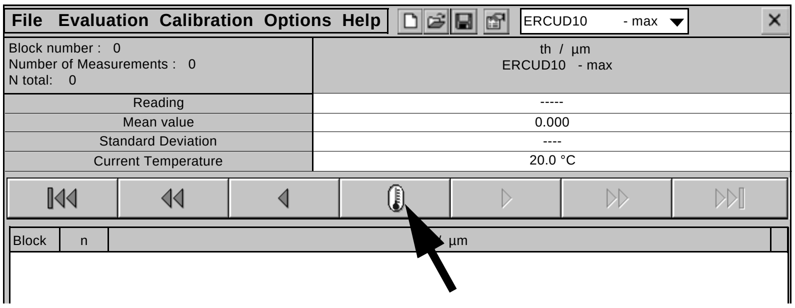
A temperature increase will cause a reduction of the measured coating thickness value. For that reason the current temperature of the specimen must take into account while measurement. All displayed measurement values are referenced to a specimen temperature of +20 °C (+68 °F).

Enter the Current Temperature of the Specimen 2-106
Normalization 2-107
Corrective Calibration 2-108

2.13.2 Enter the Current Temperature of the Specimen

Procedure

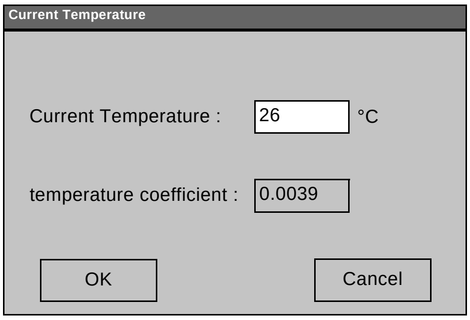
1. Open the window for temperature entry:

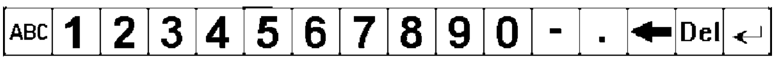


Tap the button with the stylus.

The window *Current Temperature* opens.

2. Enter the current temperature of the specimen:





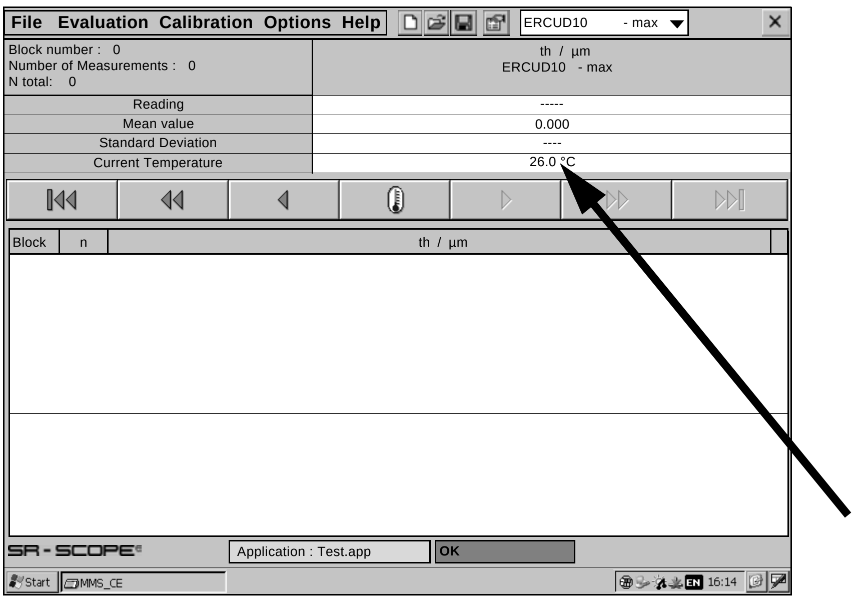
Window *Current Temperature*

1. Enter the current specimen temperature into the field. Use the entry bar at the bottom of the display, tap the numbers in succession (Example: 2 6 for a specimen temperature of 26 °C).

If the Temperature module is mounted in the instrument the temperature of the current standard can captured with the connected temperature sensor instead of manual entry. In this case tap on button **<< Temperature** to accept the sensor temperature. This button appear only if the application set up with the parameter "Temperature correction with external sensor".

2. Tap the **OK** button with the stylus.

   The window *Current Temperature* closes.



The display of the measuring mode shows the entered specimen temperature.

2.13.3 Normalization - Cu/Epoxy (Probe Types ERCU)

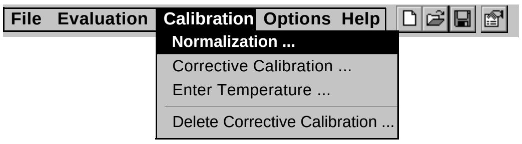
Instrument and probe must be adjusted to the copper coating material (galvanic deposited). Perform a normalization for that.

Required materials:

- **Cu**: Reference part made of galvanic deposited copper (Cu Sat. ERCU 603-139), supplied with the probe.

Procedure:

1. Calling the normalization function:

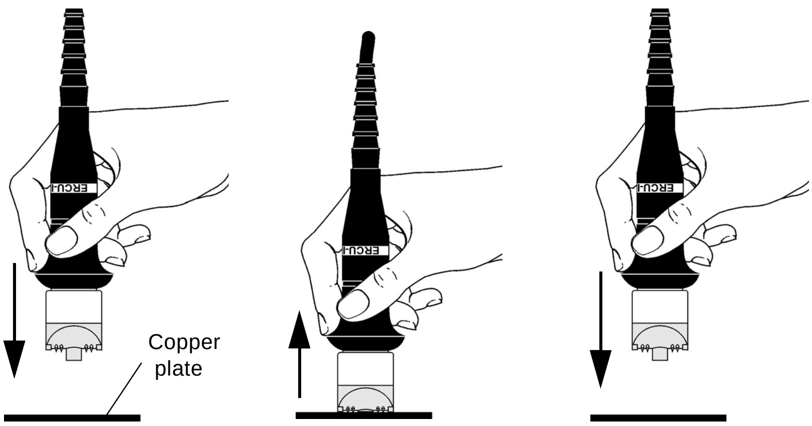


Open window *Normalization*

Tap **Calibration / Normalization ...** on the display in succession using the stylus.

The window *Normalization* opens.

2. Copper adjustment:



Window *Normalization*

1. Perform 5 to 10 measurements on the copper plate (signed with Cu Sat. ERCU 603-139).

Further information about the probe handling see section 2-111.

2. Tap the **Continue** button with the stylus.

The window *Normalization* closes.

3. Saving the parameters of the normalization in the current application:

Tap the button  with the stylus.

Save Normalization

Now measurements can be made

2.13.4 Corrective Calibration - Cu/Epoxy (Probe Types ERCU)

Necessary:

- If the trueness is not met when making measurements on customer reference parts (customer standards), a corrective calibration should be performed. A corrective calibration with the calibration plates supplied with the probe provides the best measurement accuracy for the entire range.
- Adjusting instrument and probe to the to the properties of the specimen using standards from own production.

A corrective calibration should always be performed under conditions that are comparable to those of the specimen!

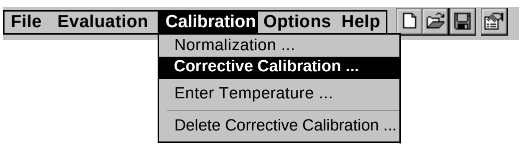
Perform the corrective calibration carefully! It determines the accuracy for the subsequent measurements. - Measurements can never be more accurate than the corrective calibration!

Required materials:

- **Cu**: Reference part made of galvanic deposited copper, supplied with the probe.
- Standards: Calibration plate(s) supplied with the probe with defined copper thicknesses (about: 12 and 70 µm or 0.46" and 2.7"; galvanic deposited) or standards from own production (galvanic deposited copper coatings).

Procedure:

1. Calling the corrective calibration function:

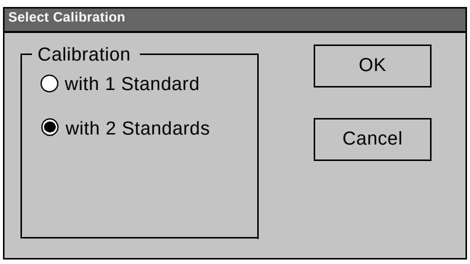


Open window *Normalization*

Tap **Calibration / Corrective Calibration ...** on the display in succession using the stylus.

The window *Select Calibration* opens.

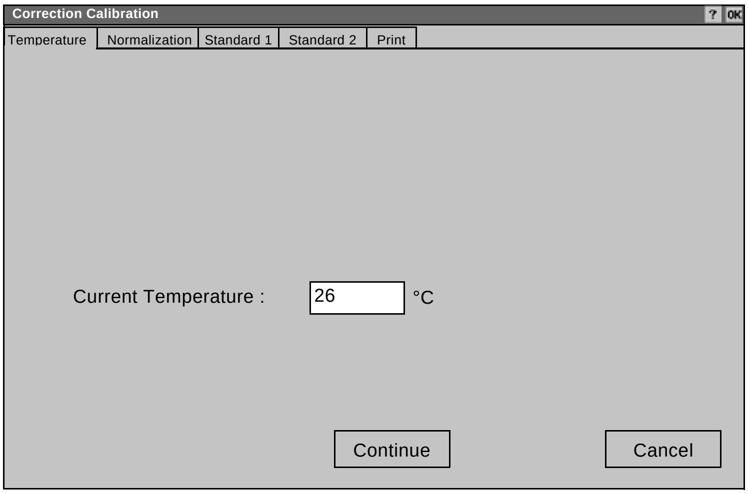
2. Select the number of coated standards used for the corrective calibration:



Window *Select Calibration*

1. Tap "**with 2 Standards**" to get the best measurement accuracy for the desired measuring range.
2. Tap the **OK** button with the stylus to confirm the selection.

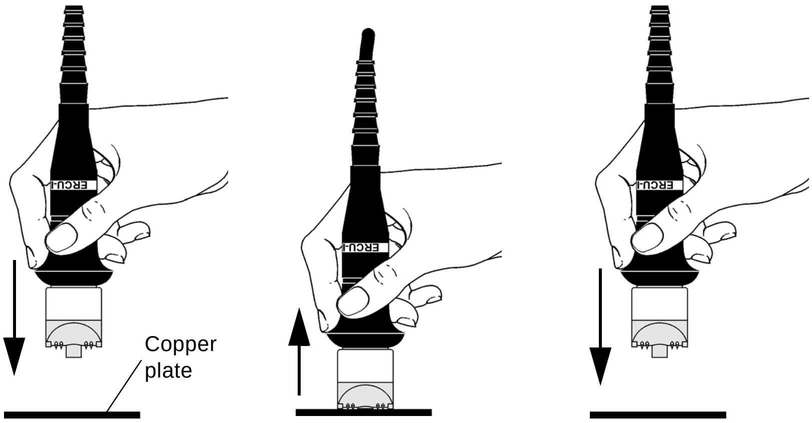
3. Enter temperature of the standards:



Window *Correction Calibration*
Tab *Temperature*

1. Enter the current standard temperature into the field. Use the entry bar at the bottom of the display, tap the numbers in succession (Example: 2 6 for a specimen temperature of 26 °C).
2. Tap the **Continue** button with the stylus.

4. Measurement on Cu (copper adjustment):



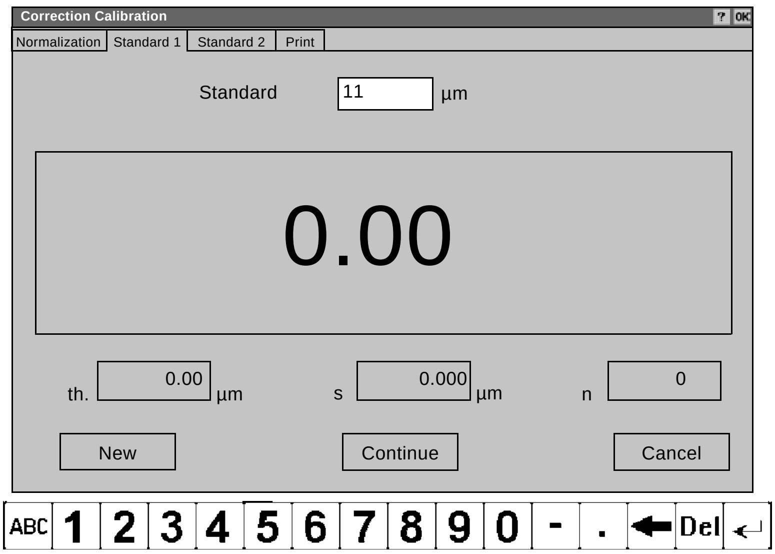
Window *Correction Calibration*
Tab *Normalization*

1. Perform 5 to 10 measurements on the copper plate.

Further information about the probe handling see section 2-111.

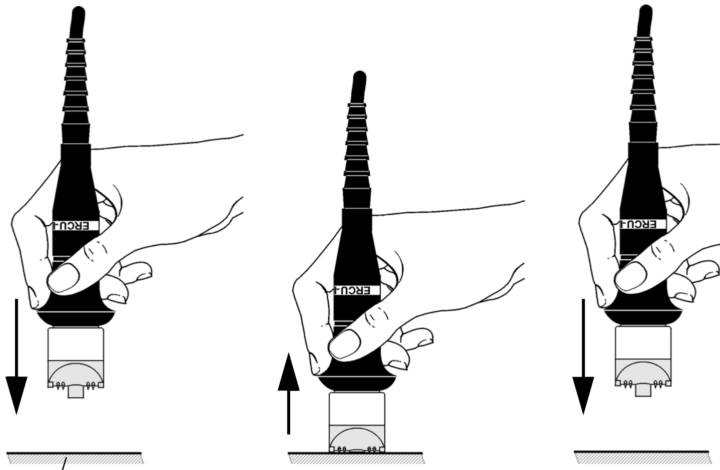
2. Tap the **Continue** button with the stylus.

5. Measurement on Standard 1 (2):



Window *Correction Calibration*
Tab *Standard 1 (2)*

1. Enter the coating thickness of the 1st (2nd) standard (plates with copper coatings, supplied by the probe) in the entry field "**Standard**". Double-tap on the entry field. Use the entry bar at the bottom of the display, tap the numbers in succession (Example: 1 1 . 6 for the copper coating thickness of 11.6 µm labeled on delivered copper plate).



Standard (typically copper coated Epoxy plate)

2. Perform 5 to 10 measurements on the Standard (calibration plate).

For the corrective calibration with only one Standard or after measurement on Standard 2 continue with step #**5.*5.***

3. Tap the **Continue** button with the stylus.

4. Perform steps **5.*1.*** to **5.*2***. with the second standard (calibration plate, supplied by the probe). Then continue with step #**5.*5.***

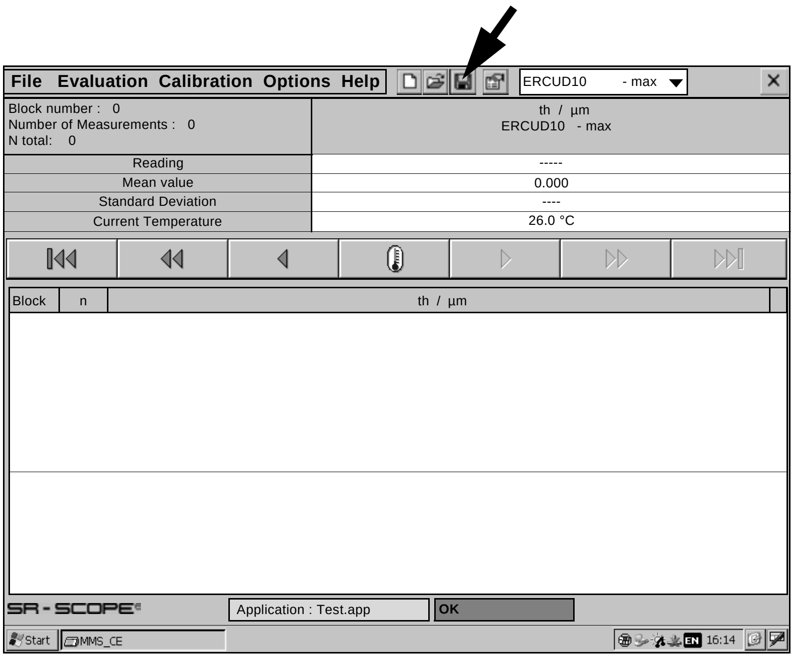
5. Tap the **Finish** button with the stylus.

The window *Correction Calibration* closes.

6. Saving the parameters of the corrective calibration in the current application:

Saving the corrective calibration

Tap the button  with the stylus.



The corrective calibration is finished and has been stored in the open application. Thus, for this application, a new corrective calibration is not required before every measurement.

Now, measurements can be made in the current application.

2.13.5 Making Measurements

Before measurement remove the yellow protective cap from the probe tip!

Put the yellow protective cap on the probe tip after a measurement or for storage purposes. This avoid the potential of injury from an unprotected probe tip and protects the pins (measurement poles) from damage.

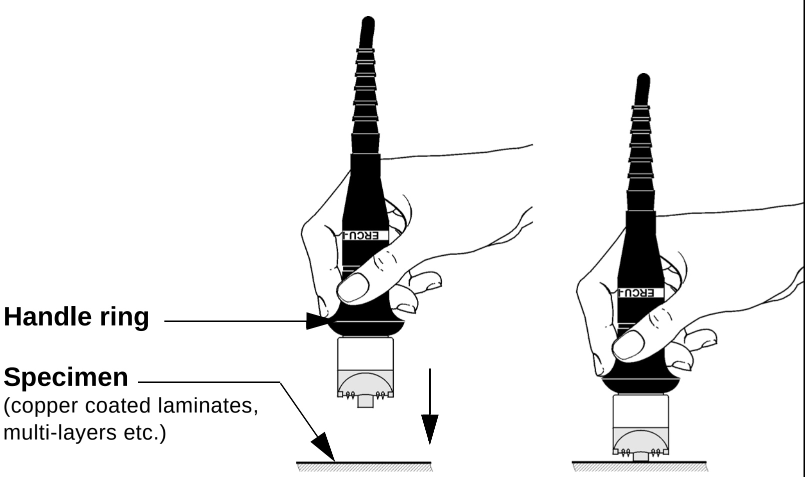
Use the ERCU probe types only for measuring copper coatings!

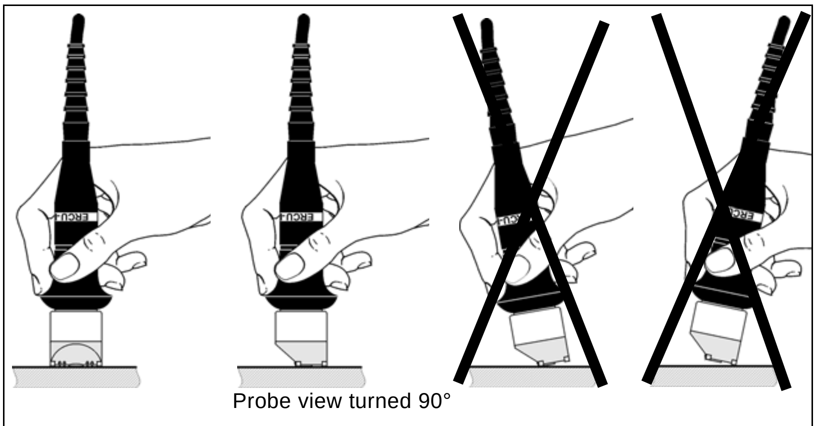
Check the temperature of the specimen before making measurements. Enter new specimen temperature if necessary (button , description of capture specimen temperature see 2-106).

To avoid injury handle the ERCU probe types properly - be particularly careful with the probe tip!

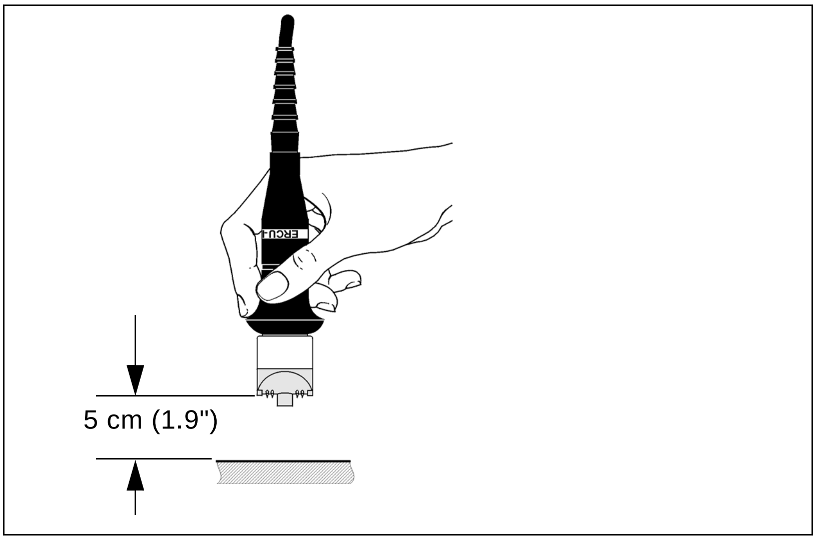
Measurements with ERCU probe type demonstrated using the ERCU D10 probe for example

Fig. 1: Handling of the ERCU probe types (example: ERCU D10)





- Always hold the probe at the handle ring as shown (fig.1). In this manner, the heat emission of the hand will not affect the measurement.
- Place the probe perpendicular on the specimen; the probe housing must have full contact with the specimen surface.
- Press the probe firmly onto the specimen till the signal tone for measurement capture sounds (default instrument setting).



- Before making the next measurement, lift the probe at least about 5 cm (1.9") off the specimen.

- **Store the measurements in the application**:

Do not move the probe after it has been positioned!

The instrument can make measurements only in the measurement mode!

Do not bend the probe cable! It may lead to line break! Bending radius of the cable $\geq$ 5 cm (1.9")!

Measurements on thin coatings

Particularly on thin coatings, never measure several times at the same location!

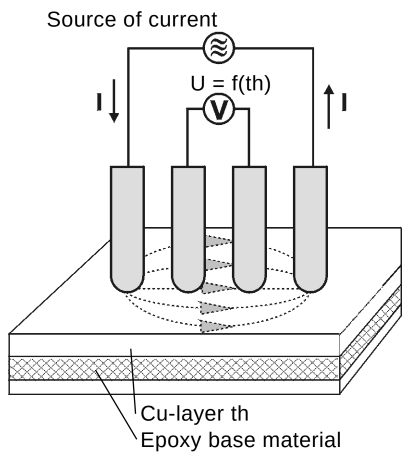
With thin coatings, the pins of the probe can penetrate the coating, which leads to changes in the electrical resistance. For this reason, never measure several times at the same location with thin coatings.

2.13.6 Probe Data

Measurement principle of the restistance test method (DIN EN ISO 14517)

The ERCU probe type operates according to the resistance method (DIN EN 14571) and is ideally suited to measure the copper thickness of laminates and multilayers. Underlying Cu coating does not influence the measurement result, even if the interim epoxy layer has a thickness of only a few micrometers.

The probe contains four pins. The two outer pins provide a current flow. The Cu coating between the two inner pins serves as the electrical resistance for measuring the voltage drop, which is in inverse proportion to the thickness of the Cu coating. The instrument converts the measurement signal from the probe and displays a coating thickness value.



Principle function of the ERCU probe

Technical Data of the ERCU Probe Model

	ERCU N - max	ERCU N - min	ERCU D10 - max	ERCU D10 - min
Coating/Substrate	Cu/Iso; as standard galvanic deposited copper coatings Measurements only on flat surfaces possible			
Measuring range	5 ... 120 µm (0.2 ... 4.8 mils)	0.1 ... 10 µm (0.004 ... 0.4 mils)	5 ... 200 µm (0.2 ... 8 mils)	0.1 ... 10 µm (0.004 ... 0.4 mils)
*Repeatability precision referenced to Fischer Standards	> 5 ... 15 µm: 0.2 µm 15 ... 120 µm: ≤ 2 % of read. > 0.2 ... 0.6 mils: 0.008 mils 0.6 ... 4.8 mils: ≤ 2 % of read.	0.1 ... 5 µm: 0.2 µm 5 ... 10 µm: ≤ 2 % of read. 0.004 ... 0.2 mils: 0.008 mils 0.2 ... 0.4 mils: ≤ 2 % of read.	>5 ... 15 µm: 0.1 µm 15 ... 200 µm: ≤ 1.5 % of read. >0.2 ... 0.6 mils: 0.004 mils 0.6 ... 8 mils: ≤ 1.5 % of read.	0.1 ... 5 µm: 0.075 µm 5 ... 10 µm: ≤ 0.7 % of read. 0.004 ... 0.2 mils: 0.003 mils 0.2 ... 0.4 mils: ≤ 0.7 % of read.
*Trueness referenced to Fischer Standards	>5 ... 50 µm: ± 0.5 µm 50 ... 80 µm: ≤ 1 % of read. 80 ... 120 µm: ≤ 2 % of read. >0.2 ... 2 mils: ± 0.02 mils 2 ... 3.2 mils: ≤ 1 % of read. 3.2 ... 4.8 mils: ≤ 2 % of read.	0.1 ... 5 µm: ± 0.075 µm 5 ... 10 µm: ≤ 1.5 % of read. 0.004 ... 0.2 mils: ± 0.003 mils 0.2 ... 0.4 mils: ≤ 1.5 % of read.	>5 ... 25 µm: ± 0.5 µm 25 ... 90 µm: ≤ 2 % of read. 90 ... 150 µm: ≤ 3 % of read. > 150 µm: ≤ 5 % of read. >0.2 ... 1 mils: ± 0.02 µm 1 ... 3.6 mils: ≤ 2 % of read. 3.6 ... 6 mils: ≤ 3 % of read. > 6 µm: ≤ 5 % of read.	0.1 ... 5 µm: ± 0.15 µm 5 ... 10 µm: ≤ 3 % of read. 0.004 ... 0.2 mils: ± 0.006 mils 0.2 ... 0.4 µm: ≤ 3 % of read.
Smallest test area	⌀ 4 mm [0.16"]		⌀ 26 mm [1"]	

	ERCU N - max	**ERCU N - min**	**ERCU D10 - max**	**ERCU D10 - min**
Distance compensation	none			
Substrate material thickness	no data			
Probe length	125 mm [4.9"]		130 mm [5.1"]	
Probe diameter, max.	⌀ 30 mm [0.71"]		⌀ 31 mm [1"]	
Measurement application Master Calibration	Specimen with flat, smooth surface			

* The specifications only be valid for probes master calibrated together with the used instrument.

2.14 Measurements with the NICKELSCOPE® Module

The module NICKELSCOPE® includes the magnetic test method according to DIN EN ISO 2178. Well suited for coating thickness measurements on magnetic substrate materials.

2.14.1 Influencing Variables Taken into Consideration

For correct measurements of the coating thickness, the instrument and the probe, together referred to as the measurement system, must “become familiar” with the specimen (part). This is done using a calibration. The influencing parameters are captured using a reference part and can then be compensated in future measurements. The calibration is preformed for the respective open Application. The correction factors determined in this step must be stored in the open Application (measuring application file).

Main variables influencing the coating thickness measurement for measurments with the NICKELSCOPE® module (magnetic test method):

Coating/ substrate material	**Influencing variables**	**Probe**	Normalisation Page	Corrective Calibration Page
Ni/NF, Ni/Iso	● Magnetic permeability of the electroplated Ni coating	EN3 (Ni/NF)	2-117	2-119
NF/Fe	● Magnetic permeability if the ferrous substrate material	EN3 (NF/Fe)	2-124	2-126
Valid for Ni/NF, Ni/Iso and NF/Fe	● The geometric design of the specimen such as thickness of the substrate material or a cylindrical shape.	EN3	-	-

NF: non-ferromagnetic, electrical conductive material as copper, aluminum, zinc, ...
Iso: electrically non-conductive and non-ferromagnetic material as plastic, epoxy, ...
Fe: magnetizable material of steel or iron
Ni: Nickel

In calibration, we distinguish between normalization and corrective calibration.

Normalization

The normalization is the simplest kind of calibration and is used for adapting the measurement system to a reference point. For the measuring method of the module NICKELSCOPE®, these are the base material (magnetizable or non-magnetizable and electrically non-conducting). Measurements are made on a reference part that corresponds in material and shape to the actual part to be measured. It consists only of the base material, i.e., without the coating material to be measured. Care should be taken during the calibration to ensure that the measurement location on the reference part is approximately at the same position where it will be on the part to be measured (curvature, distance to edge, hole, offset and step).

Corrective Calibration

The corrective calibration adjust the measurement system to the properties of the specimen. The corrective calibration not only adjusts the system to the substrate material but also to 1 to 2 coating thickness values by using so-called calibration foils or standards.

If the trueness is not met when making measurements on customer reference parts (customer standards), a corrective calibration should be performed.

In general, the material properties (permeability) of the specimen will differ significantly from those taken into account in the factory pre-calibration. **It is, therefore, essential to perform the normalization or corrective calibration, respectively, using uncoated reference parts (specimens) from your own production!**

2.14.2 Variables Influencing the Measurement of Electroplated Nickel Coatings

- The magnetic permeability of the electroplated Ni coatings deposited on electrically non-conductive or non-ferrous substrates significantly influences the measurement. **A normalization or corrective calibration (adjustment of the measuring system to the specimen) using typical standards from the production is, therefore, absolutely necessary.**

  The coating material may not consist of several Ni sheets or foils. There is always an air gap between two foils/sheets that causes demagnetization and influences the measurement.

Depending on the required accuracy, a normalization (coating material adjustment) does not suffice and a corrective calibration may need to be performed. For a better adjustment to the material properties (permeability) of the specimen, we therefore recommend using 2 calibration standards for the corrective calibration.

The corrective calibration applies only to the open application and the coating thickness ranges of the used standards, respectively. The correction factors determined during the corrective calibration must be stored in the open application file.

Normalization, 2-117
Corrective Calibration, 2-119

2.14.3 Normalization - Ni/NF or Ni/NC (Probe EN3)

Instrument and probe must be adjusted to the Ni coating material.

Required materials/standards (from own production):

Ni Saturation:

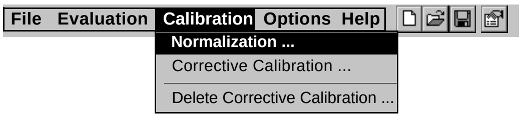
Reference part made of the coating material (Ni) having a thickness at least of 3 or 4 times to the depth of the penetration of the probe used. For thin Ni coatings up to 50 µm the Ni saturation standard included with the shipment can be used. For thicker Ni coatings the material of the Ni saturation standard should be the same as used for the Nickel anode in the electroplating process or should be made from the coating material of the parts to be measured.

Mark the measurement area on the Ni Saturation part at the location where it will be on the actual specimen.

! **Please note, if the nickel bath has changed, a new Ni Saturation has to be made.**
The measurement system must be adapted to the changed nickel bath properties before making measurements on parts from the new bath. For this purpose, a new normalization with a new Ni saturation set up from the new nickel bath has to be performed.

Procedure:

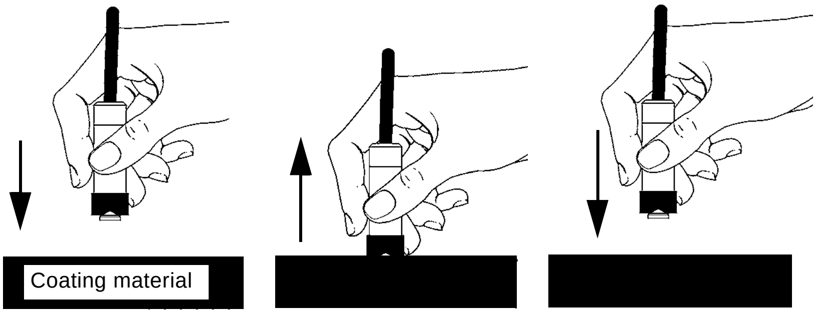
1. Calling the normalization function:



Open window *Normalization*

Tap **Calibration / Normalization ...** on the display in succession using the stylus.

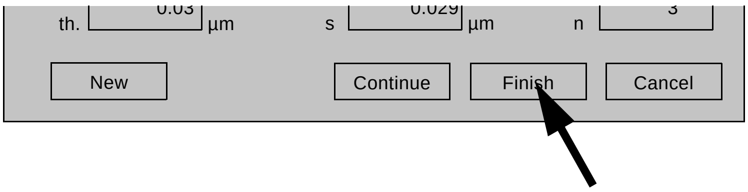
2. Measurement on Ni coating material:



Window *Normalization*

Perform 5 to 10 measurements on the Ni coating material (= Ni Saturation, only Ni coating material). Place the probe on the marked measurement area.

3. Finishing the normalization:



Close window *Normalization*

Tap the **Finish** button with the stylus.

4. Saving the parameters of the normalization:

Tap the button  with the stylus.

Saving Normalization in the current application

Now measurements can be made

2.14.4 Corrective Calibration - Ni/NF or Ni/NC (Probe EN3)

Necessary:

- If the trueness is not met when making measurements, a corrective calibration should be performed.
- Adjustment the measuring system (instrument and probe) to in-house calibration standards.

The corrective calibration applies only to the open application, or to all applications linked to the open one and the coating thickness ranges of the used standards, respectively. This means, an accurate measurement with great trueness (accuracy) is possible only in this range. A new corrective calibration (possibly in a new and different application) must be performed for measurements outside of this coating thickness range. For example, the coating thicknesses of the calibration standards should be about 15 and 25 µm if the Ni thickness to be measured is about 20 µm. If the Ni thickness to be measured changes to about 40 µm, then a new corrective calibration must be performed using calibration standards with suitable Ni thicknesses (for example, 35 and 45 µm).

A corrective calibration should always be performed under conditions that are comparable to those of the specimen!
Same substrate material for the calibration standard and for the specimen, same curvature, etc.!

Perform the corrective calibration carefully! It determines the accuracy for the subsequent measurements. - Measurements can never be more accurate than the corrective calibration!

Required materials/standards (from own production):

- Ni Saturation: Reference part made of the coating material (Ni) having a thickness at least of 3 or 4 times to the depth of the penetration of the probe used. For thin Ni coatings up to 50 µm the Ni saturation standard included with the shipment can be used. For thicker Ni coatings the material of the Ni saturation standard should be the same as used for the Nickel anode in the electroplating process or should be made from the coating material of the parts to be measured.

- Calibration standard(s): Coated part from the production with known Ni coating thickness in the range of the coated parts to be measured and which corresponds to the substrate and coating material of the parts to be measured.

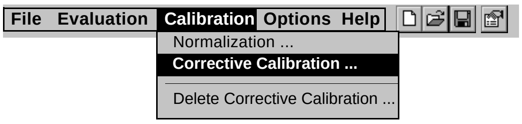
  The coating material may not consist of several Ni sheets or foils. There is always an air gap between two foils/sheets that causes demagnetization and influences the measurement.

Information on creating in-house calibration standards can be found beginning on page 2-130.

Please note, a change of the nickel bath causes the creation of a new Ni Saturation!
The measurement system must be adapted to the changed nickel bath properties before making measurements on parts from the new bath. For this purpose, a new normalization with a new Ni saturation set up from the new nickel bath has to be performed.

Procedure:

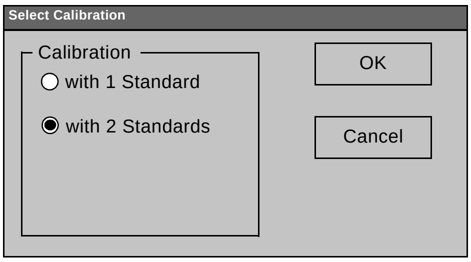
1. Calling the corrective calibration function:



Open window *Correction Calibration*

Tap **Calibration / Corrective Calibration ...** on the display in succession using the stylus.

2. Select the number of coated standards used for the corrective calibration:



Window *Select Calibration*

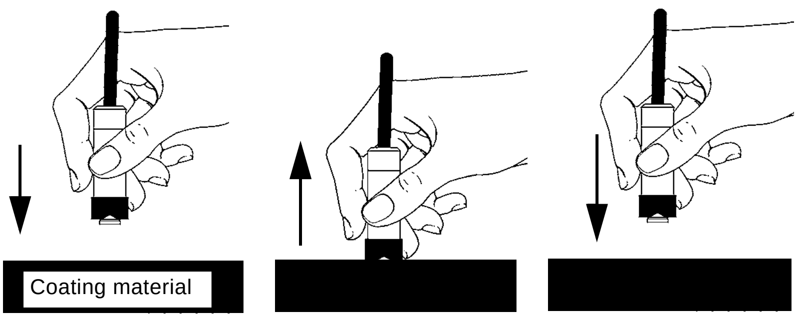
1. Tap the desired number of coated standards to be used.

"**with 2 Standards**" get the best measurement accuracy for the entire probe range.

2. Tap the **OK** button with the stylus to confirm the selection.

The window *Correction Calibration* opens.

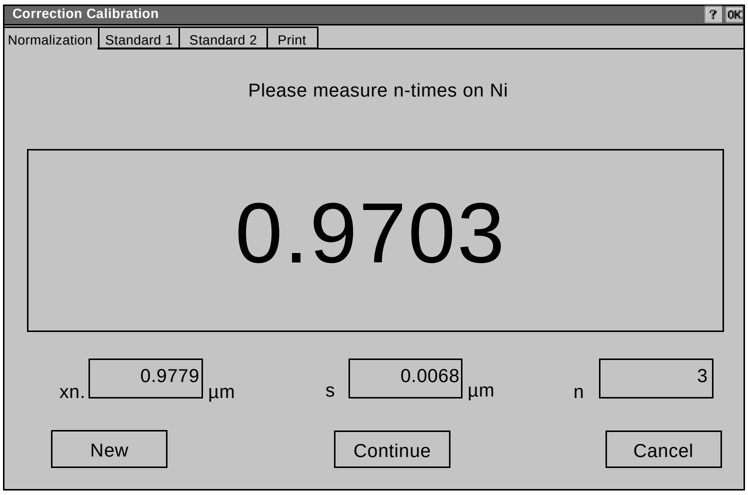
3. Measure on Saturation (Ni) (coating material adjustment):



Window *Correction Calibration*
Tab *Normalization*

1. Perform 5 to 10 measurements on the coating material standard (= Ni Saturation).

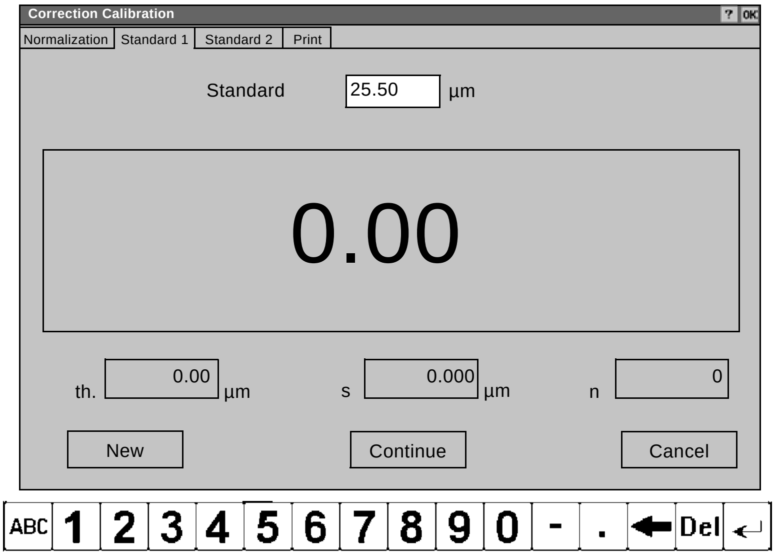
Tap **Continue** button with



the stylus.

4. Measurement on Standard 1(2):

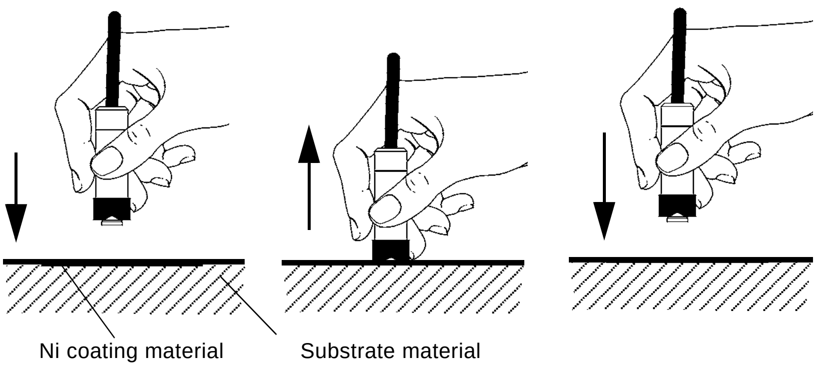
Window *Correction Calibration*
Tap *Standard 1 (2)*



1. Check the displayed coating thickness value (field Standard) with the coating thickness value of the present standard. If the displayed standard thickness does not correspond to the coating thickness of the present standard, enter the thickness that is specified on the present standard into the field "Standard": Double-tap on the entry field. Use the entry bar at the bottom of the display, tap the numbers in succession (Example: 2 5 . 5 for the coating thickness of 25.5 µm labeled on standard).
2. Perform 5 to 10 measurements on the standard 1 (or 2).

For the corrective calibration with only one standard, or after the measurement on standard 2 continue with step # **4.5.**

3. Tap **Continue** button with



Coated part from the production with known Ni coating thickness on non-magnetic or electrical non-conductive substrate material.

the stylus.

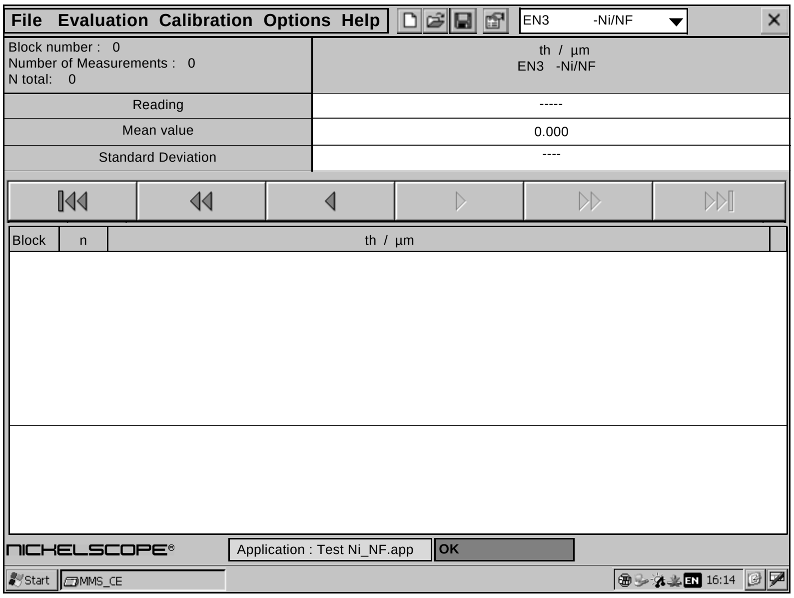
4. Perform steps **4.*1.*** to **4.*2.*** with the second standard. Then continue with step #**4.*5.***

5. Tap the **Finish** button with the stylus.

   The window *Correction Calibration* closes.

5. Saving the parameters of the corrective calibration in the application:

Save corrective calibration



Measuring mode Numeric Display (example)

Tap the button  with the stylus.

The corrective calibration is finished and has been stored in the open application. Thus, for this application, a new corrective calibration is not required before every measurement.

Now, measurements can be made.

2.14.5 Variables Influencing the Measurement of Non-ferrous Metal Coatings on Steel or Iron

The main variables influencing the measurement of non-ferrous metal coatings (Aluminum, Zinc, Plumbum, Copper, ...) on steel or iron are:

- Physical properties of the specimen substrate material such as the permeability.
- The geometric design of the specimen such as the thickness of the substrate material or a cylindrical shape.
- The position of the measurement spot on the specimen: distance to the edge, hole, offset or step.
- Surface roughness.

In most cases, the influencing variables mentioned above can be taken into account using a normalization (substrate material adjustment).

In general, the material properties (permeability) of the specimen will differ significantly from those taken into account in the factory pre-calibration. **It is, therefore, essential to perform the normalization or corrective calibration, respectively, using reference parts (specimens) from your own production!**

Depending on the required accuracy, a corrective calibration may need to be performed as well. For a better adjustment to the material properties (permeability) of the specimen, we therefore recommend using 2 calibration standards for the corrective calibration.
A corrective calibration is performed for the respective open application. The correction factors determined during the corrective calibration must stored in the open application.

Normalization, 🗐 2-124
Corrective Calibration, 🗐 2-126

2.14.6 Normalization - NF/Fe (Probe EN3)

Instrument and probe must be adjusted to the ferromagnetic substrate material of the specimen.

Required Material:

BASE: Ferromagnetic, uncoated reference part (specimen) from the customer's **own** production. Specimen **without the coating to be measured**.

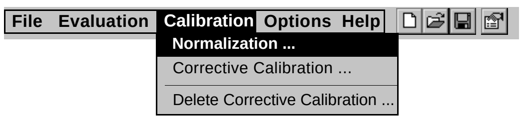
For creating a Base, take a specimen from the production and remove the coating (e.g. grind off, the surface should be clean or polished). Geometries and material properties of the uncoated reference part must correspond to those of the actual specimen. Mark the measurement area on the uncoated reference part at the location where it will be on the actual specimen.

Do not use the supplied metal board (NF/FE) or the Fe Base 602-661!!!
As a rule, the material properties will not correspond to those of the uncoated specimen! Use it only for instrument check!

Please note:
The substrate material from different batches will have different permeabilities. This means that the measurement system must be adapted to the changed material properties before making measurements on specimens from the new batch. For this purpose, the Base must be set up from the new batch!

Procedure:

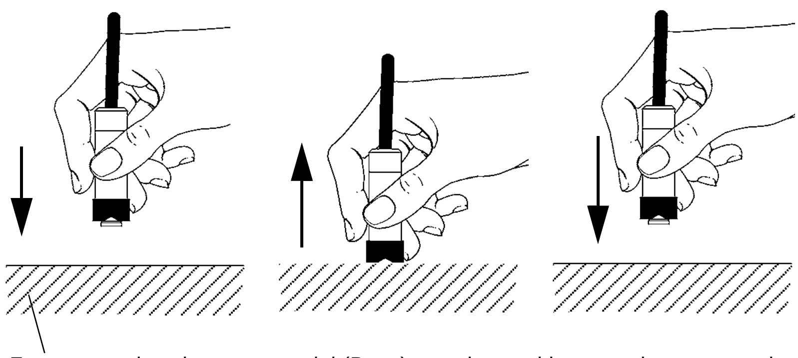
1. Calling the normalization function:



Open window *Normalization*

Tap **Calibration / Normalization ...** on the display in succession using the stylus.

2. Measurement on substrate material:



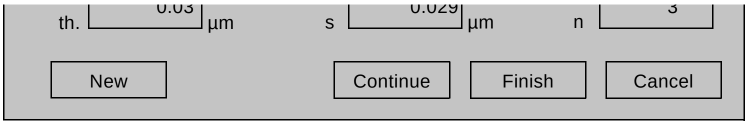
Ferromagnetic substrate material (Base), specimen without coating, uncoated reference part from customer's own production.

Place the probe on the marked measurement area.

Window *Normalization*

Perform 5 to 10 measurements on the uncoated reference part (= Base, specimen without the Ni coating).
Place the probe on the marked measurement area.

3. Finishing the normalization:



Close window *Normalization*

Tap the **Finish** button with the stylus.

4. Saving the parameters of the normalization:

Tap the button  with the stylus.

Saving Normalization in the current application

Now measurements can be made

2.14.7 Corrective Calibration - NF/Fe (Probe EN3)

Necessary:

- If the trueness is not met when making measurements, a corrective calibration should be performed. A corrective calibration with the calibration foils supplied with the probe provides the best measurement accuracy for the entire range.
  To improve the accuracy in a certain thickness range, a foil should be used with a thickness that corresponds to the expected coating thickness of the specimen. However, the accuracy outside this particular thickness range is typically worse than with the corrective calibration using the supplied calibration foils.

A corrective calibration should always be performed under conditions that are comparable to those of the specimen!
Same substrate material for the calibration standard and for the specimen, same curvature, etc.!

Perform the corrective calibration carefully! It determines the accuracy for the subsequent measurements. - Measurements can never be more accurate than the corrective calibration!

Required materials:

- Base: Ferromagnetic, uncoated reference part (specimen) from the customer's **own** production. Specimen **without the coating to be measured**.

  For creating a Base, take a specimen from the production and remove the coating (e.g. grind off, the surface should be clean or polished). Geometries and material properties of the uncoated reference part must correspond to those of the actual specimen. Mark the measurement area on the uncoated reference part at the location where it will be on the actual specimen.

Do not use the supplied metal board (NF/FE) or the Fe Base 602-661!!!
As a rule, the material properties will not correspond to those of the uncoated specimen! Use it only for instrument check!

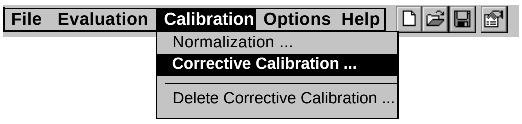
Please note:
The substrate material from different batches will have different permeabilities. This means that the measurement system must be adapted to the changed material properties before making measurements on specimens from the new batch. For this purpose, the Base must be set up from the new batch!

- Standards: Calibration foil(s) supplied with the probe or a calibration foil with a thickness that corresponds to the coating thickness to be measured. If the coating thickness to be measured is, for example, at about 15 µm, foil thicknesses of about 9 and 24 µm should be used for the corrective calibration. On the foil, the measurement area is marked with a circle.

Please contact your authorized distributor or Helmut Fischer GmbH directly for calibration foils with suitable thicknesses. www.helmut-fischer.com

Procedure:

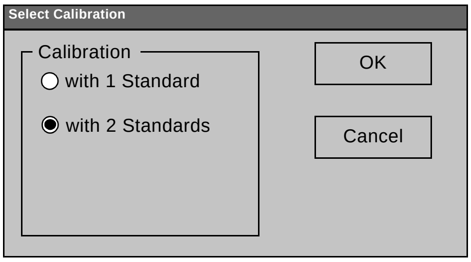
1. Calling the corrective calibration function:



Open window *Correction Calibration*

Tap **Calibration / Corrective Calibration ...** on the display in succession using the stylus.

2. Select the number of standards (calibration foils) used for the corrective calibration:



Window *Select Calibration*

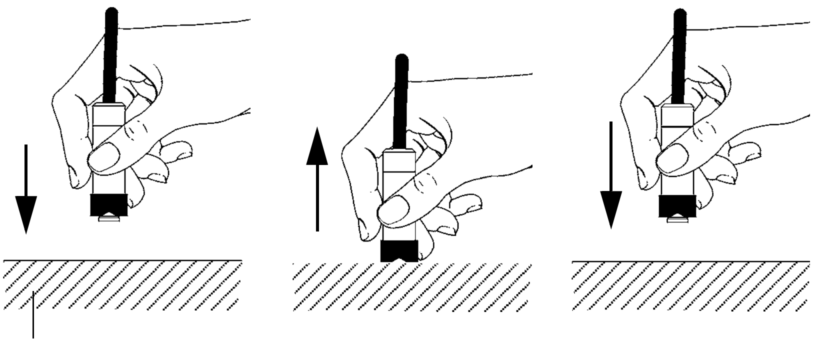
1. Tap the desired number of coated standards to be used.

"**with 2 Standards**" get the best measurement accuracy for the entire probe range.

2. Tap **OK** button with the stylus to confirm the selection.

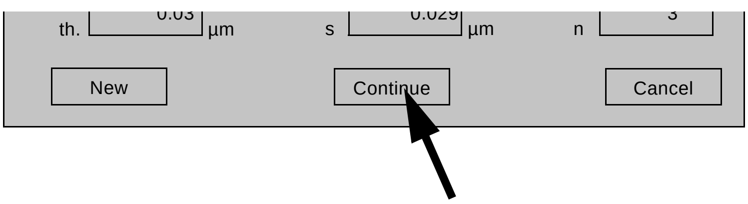
The window *Correction Calibration* opens.

3. Measurement on Fe (Substrate material adjustment):



Ferromagnetic substrate material (Base), specimen without coating, uncoated reference part from customer's own production.

Place the probe on the marked measurement area.

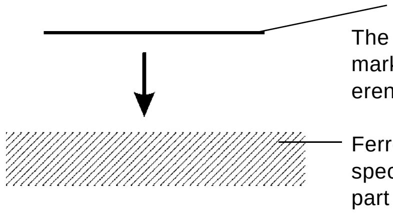


Window *Correction Calibration*
Tab *Normalization*

1. Perform 5 to 10 measurements on the substrate material (= Base, uncoated specimen).

2. Tap the **Continue** button with the stylus.

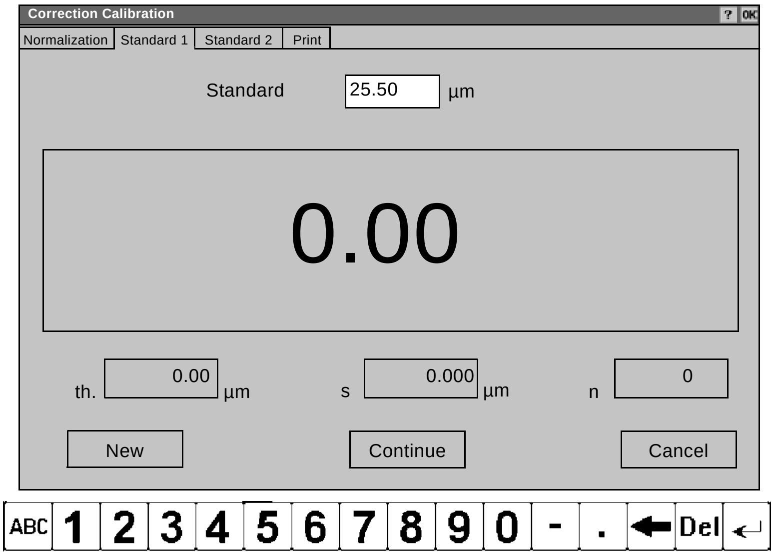
4. Measurement on Standard 1(2) (calibration foil):

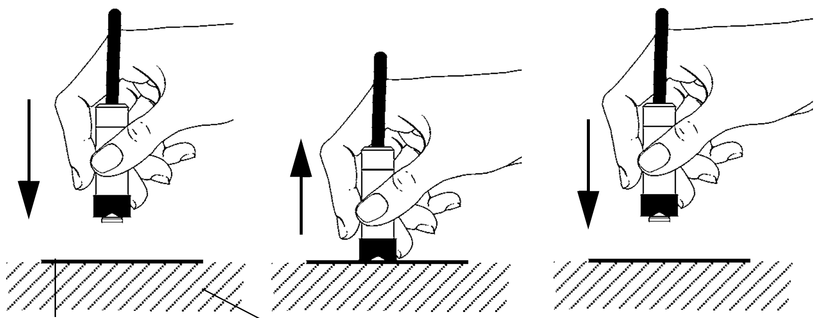


Standard

The circle on the calibration foil must be on the marked measurement area of the uncoated reference part.

Ferromagnetic substrate material (Base), specimen without coating, uncoated reference part from customer's own production.





Calibration foil (standard) Ferromagnetic substrate material (BASE)

Place the probe inside the circle of the calibration foil.

Window *Correction Calibration*
Tab *Standard 1 (2)*

1. Place the calibration foil with the defined thickness onto the ferromagnetic substrate material (= BASE).

Only one foil at a time may be placed on the reference part! When using 2 standards (calibration foils): Remove calibration foil 1 for the second run and only then place calibration foil 2.

2. The displayed standard thickness does not correspond to the thickness of the foil that is placed on the substrate. In this case, enter the thickness that is specified on the calibration foil into the field "**Standard**": Double-tap on the entry field (to the right of Standard). In the entry bar at the bottom of the display, tap the numbers/ characters in succession (Example: 2 5 . 5 for a foil thickness of 25.5 µm).

3. Perform 5 to 10 measurements on the calibration foil (= Standard 1 resp. 2). For this purpose, place the probe inside the circle onto the foil.

For the corrective calibration with only one calibration foil, or after the measurement on Standard 2 continue with step # **4.*6.***

4. Tap the **Continue** button with the stylus.

5. Perform steps **4.*1.*** to **4.*3.*** with the second calibra-

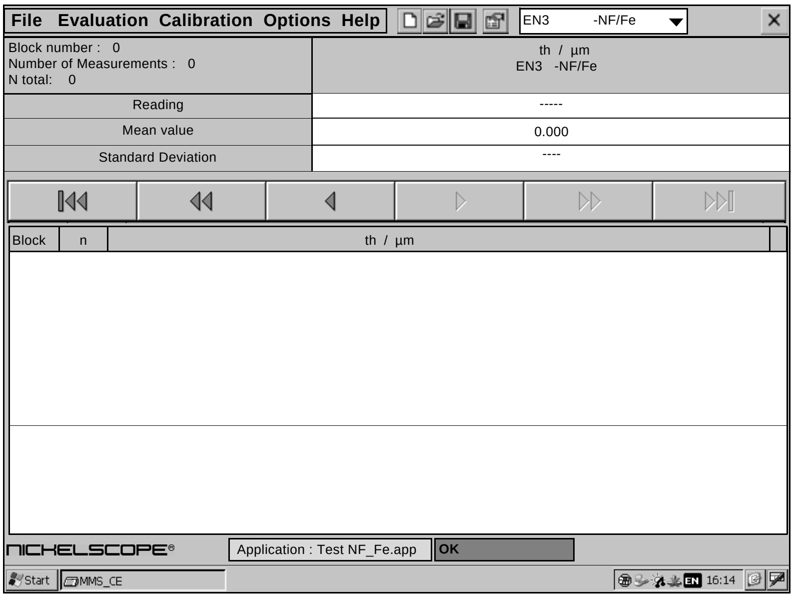
tion foil (Standard 2). Then continue with step # **4.*6.***

6. Tap the **Finish** button with the stylus.

The window *Correction Calibration* closes.

5. Saving the parameters of the corrective calibration in the current application:

Save corrective calibration



Measuring mode Numeric Display;
Example for an application setting up with the probe EN3 for the application NF/Fe.

Tap the button with the stylus.

The corrective calibration is finished and has been stored in the open application. Thus, for this application, a new corrective calibration is not required before every measurement.

Now measurements can be made.

2.14.8 Preparing In-House Coated Calibration Standards

The measurement signal is dependent on the coating thickness and on the permeability of the Ni coating materials. A calibration standard must be prepared to take the permeability into account. Using this calibration standard in a corrective calibration, the measuring system can then be adjusted to the properties of the specimen.

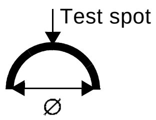
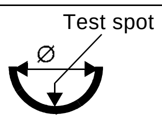
A specimen is taken from the production to prepare a calibration standard. The specimen must exhibit a uniform coating thickness distribution in order to assign a coating thickness value to this specimen. Measurements are made at several locations of the specimen to determine the coating thickness distribution. Because only the coating thickness fluctuations are of interest and not the absolute value, even an instrument (MMS® PC2) that has not yet undergone final calibration can be used. The coating thickness distribution can now be determined based on the measurement fluctuations (standard deviation). Once a specimen with a uniform coating thickness distribution (low standard deviation) has been found from the production, the (absolute) coating thicknesses are then measured using a different measuring method (e.g., coulometric or x-ray fluorescence method). Based on the uniform coating thickness distribution, the mean value from these measurements specifies the coating thickness value for the specimen. By assigning a coating thickness value, the specimen becomes a calibration standard. A measurement spot with the assigned thickness value, and where the measurements will take place during the corrective calibration, must be marked on the calibration standard.

Please note, a change of the nickel bath causes the creation of a new Ni Saturation!
The measurement system must be adapted to the changed nickel bath properties before making measurements on parts from the new bath. For this purpose, a new normalization with a new Ni saturation set up from the new nickel bath has to be performed.

The coating material may not consist of several Ni sheets or foils. There is always an air gap between two foils/sheets that causes demagnetization and influences the measurement.

2.14.9 Probe Specifications

Probe type EN3

Probe type	EN3	EN3
Coating/substrate material	NF/Fe	Ni/NF
Measurement range	0.02 ... 4 mm [0 ... 160 mils]	1 ... 150 µm [0.04 ... 6 mils]
*Repeatability precision referenced to Fischer Standards	0.01 ... 0.25 mm: 0.001 mm 0.25 ... 4 mm: ≤.0.5 % of reading [0 ... 10 mils: 0.004 mils] [10 ... 160 mils: ≤ 0.5 % of reading]	1 ... 20 µm: 0.2 µm 20 ... 150 µm: ≤ 1 % of reading [0.04 ... 0.8 mils: 0.008 mils] [0.8 ... 6 mils: ≤ 1 % of reading
Trueness referenced to Fischer Standards	0.01 ... 0.25 mm: ± 0.002 mm 0.25 ... 2 mm: ≤ 1 % of reading 2 ... 4 mm: ≤ 2 % of reading [0 ... 10 mils: ± 0.008 mils] [10 ... 80 mils: ± 1 % of reading] [80 ... 160 mils: ≤ 2 % of reading]	1 ... 15 µm: ± 0.3 µm 15 ... 150 µm: ≤ 2 % of reading [0.04 ... 0.6 mils: ± 0.012 mils] [0.6 ... 6 mils: ≤ 2 % of reading]
Probe tip diameter	0.75 mm [30 mils]	
Distance compensation	no	
*  Ø for ≥10 % measurement deviation at the master calibration on flat surface.	⌀≤ 22 mm [880 mils]	⌀≤ 10 mm [400 mils]
*  Ø for ≥10 % measurement deviation at the master calibration on flat surface.	⌀≤ 40 mm [1.575“] (⌀ 40 mm results 4 % measurement deviation)	⌀<< 10 mm [400 mils]
*Test area diameter for error ≥ 10 %	⌀≤ 20 mm [800 mils] no edge influence for ⌀ ≥ 60 mm [2.4“]	⌀≤ 8 mm [320 mils]
*Substrate material thickness for error ≥ 10 %	≤ 0.1 mm [4 mils]	-
Probe length	80 mm [3.15"]	
Probe diameter	13 mm [0.52"]	
Measurement application Master Calibration	Specimen with flat, smooth surface	

* The specifications only be valid for probes master calibrated together with the used instrument.

3 Coating Thickness Measurements Using the Beta-Backscattered Test Method

Measurements with the BETASCOPE® Module

This module includes the beta-backscatter test method according to ISO 353 and ASTM B567. This module is well suited for thickness measurements of oil and grease films, lacquer, plastic or ceramic coatings on nonferrrous metals, ison or insulating materials. Also used to make material reference measurements, e.g., determination of the uniformity of fabrics.

3.1 The Path to Making Measurements

1. Connect the instrument to line power (100 ... 240 VAC, 50 ... 60 Hz)
(Instrument connection "12VCD/1.2").

The line voltage must correspond to the one stated on the nameplate of the plug-in power supply!

2. Connect the probe / measuring stage to the module BETASCOPE® of the instrument. (Connect the Z15NGA-TC probe additionally to the module TEMPERATURE.)

The procedure for installing the beta source (isotope) and the aperture ring in the measuring stage or in the hand-held probe can be found in the instructions:
- "Instructions for Handling Beta Sources" (included with the beta source (isotope)),
- Probe or measuring stage instructions (included with the measuring stage and the hand-held probe).

3. Switching the instrument on: Press the orange **ON/OFF** key on the front of the instrument

4. Set up the memory area (file) for the measurement application in the instrument (Setting up an application), 3-2. / Calling an application (file), 3-31.

5 Saving an application (measurement application file) in the instrument, 3-32.

6. Take influencing variables into account by adjusting the measuring system (beta source (isotope), aperture ring and instrument) to the specimen (normalization, calibration), 3-12.

7. Perform the measurement(s), 3-23.

8. View/print the evaluation (characteristic statistic quantities, graphical display of the characteristic quantities, 3-28/3-29.

3.2 Setting Up a New Measurement Application File (Application)

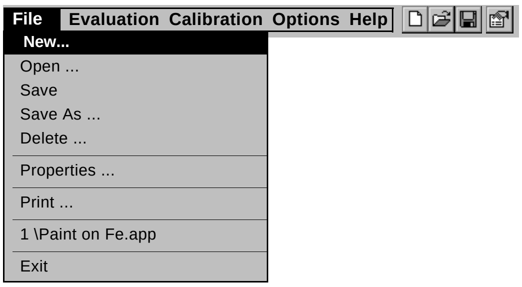
A file - the so-called application must be defined before making measurements with the FISCHERSCOPE® MMS® PC2. An application contains all data relevant for a measurement application. A measurement application is not only characterized by the material properties and the geometric shape of the specimen but also by probe type (measurement method, serial number of the probe). A new measurement application is present if one of these quantities changes and a new application must be set up.

The material properties and the coating / substrate material combination of the specimen, the isotope in use, the aperture platen, the correction factors obtained during calibration and a few measurement application-specific settings are predefined and the measurement data are stored in an application.

Before making measurements, the detector (counter tube) requires 10 to 15 minutes to reach its operating temperature. Connect the beta source (measuring stage, hand-held probe) to the MMS® PC2, place the specimen or the protective cap on the beta source (or vice versa, depending on the type of measuring stage or whether a hand-held probe is used), switch the MMS® PC2 on and wait for at least 10 to 15 minutes; the detector will then have reached its operating temperature.

Procedure

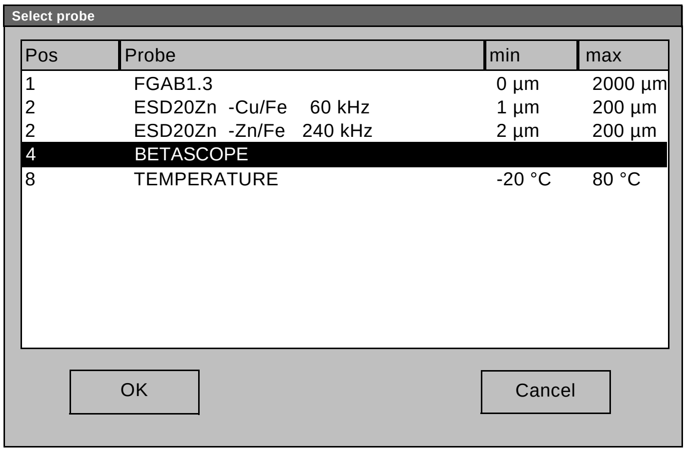
1. Calling the submenu "New ...":



Using the stylus, tap **File / New ...** on the display in succession.

The window *Select probe* opens.

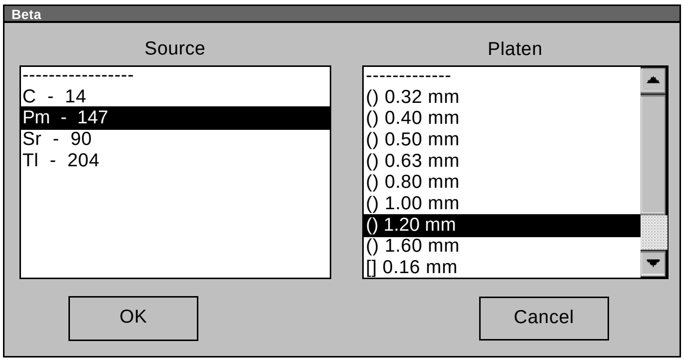
2. Selecting the beta source (isotope) and aperture platen: Window *Select probe*



Pos	Plug-in position of the module, where the selected probe is connected.
Probe	Probe name, identical to the name on the probe connector or cable. BETASCOPE indicates the BETASCOPE® module TEMPERATURE indicates the Temperature module, if mounted in the instrument.
min and max.	Measuring range of the probe

1. Tap "BETASCOPE" using the stylus. The selected name will be highlighted in blue.

2. Tap the **OK** button with the stylus. The window *Beta* opens.



3. Select the beta source (isotope) in use and the platen (aperture platen). E.g., source "Pm-147" and platen "( ) 1.20 mm" for a Promethium isotope (Pm-147) and an aperture platen with an opening diameter of 1.2 mm.

4. Tap the **OK** button with the stylus.

Next follows the calibration.

Calibration for the measurement of organic coatings (e.g., oil, lacquer): use foils as standards (on request).

Calibration of measurements of metallic coatings: Use standards of the Fischer calibration standard set or standards produced by your company. (Fischer calibration standard set on request).

Additional information for the calibration can be found to the left and beginning on page 3-12.

3. Select the type of temperature compensation:

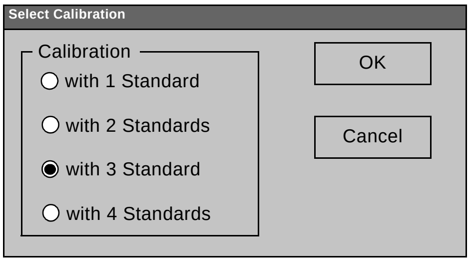
1. Most measurement applications do not require temperature compensation. Leave the default setting "no temperature compensation" unchanged and continue with step **3.*2***.

Exception: Measurements using the Z15NGA-TC probe. For this probe, tap the parameter "Temperature correction with the temperature sensor of the probe" and "Automatic temperature correction" using the stylus.

🗐 For making measurements, please read the section "Making Measurements with Temperature Compensation, page 3-27.

2. To confirm the selection or to continue, tap the **OK** button.

4. Select the number of foils or of <u>coated</u> calibration standards that are available for the calibration.

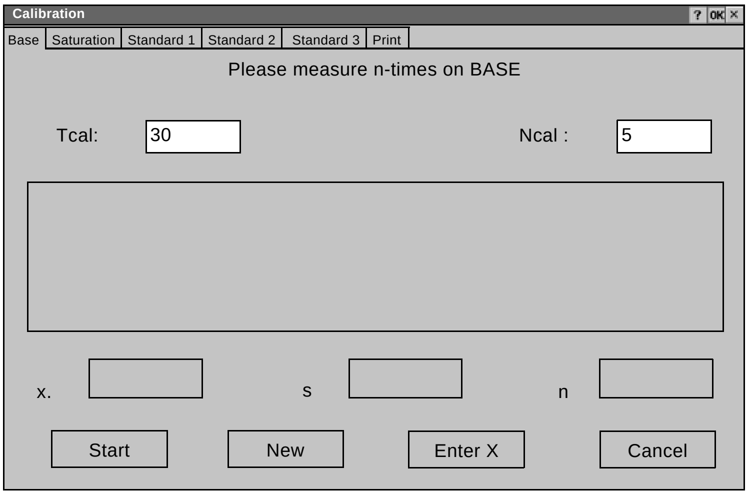


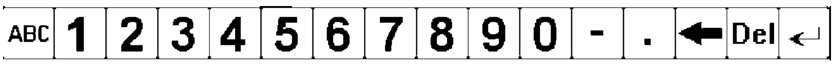
1. Tap the parameter "**with 3 standards**" (Example).

2. Tap the **OK** button using the stylus.

3. The *Calibration* window opens.

5. Enter the measuring time:



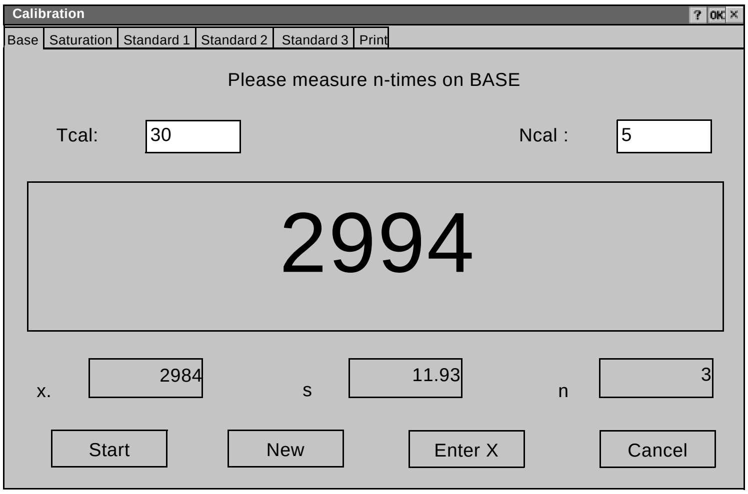


Enter a measuring time of 30 seconds: Double-tap the entry field to the right of "Tcal". On the entry bar at the bottom of the display, tap in succession the numbers (3 0).

6. Material adjustment:

The measurement system must be adjusted to the materials of the specimen.
Substrate material: Specimen without the coating to be measured or Base from the Fischer calibration standard set (e.g., Ni Base).
Coating material: Part made exclusively of the coating material or ∞ standard from the Fischer calibration standard set (e.g., Au ∞)

When the measurement series is finished, the instrument will switch automatically to the next tab.



1. Perform 5 measurements on the substrate material (= Base).

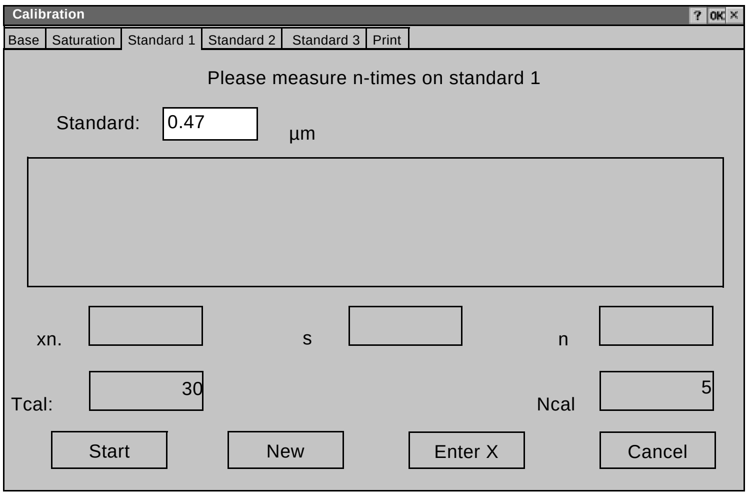
Place the BASE anew for each measurement. Start each measurement by tapping the **Start** button.

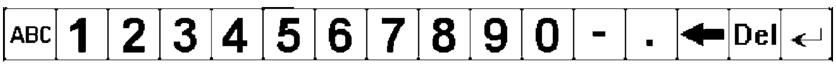
When the measurement series is finished, the instrument will switch automatically to the next tab.

2. Perform 5 measurements on the coating material (= saturation).

Place the saturation anew for each measurement. Start each measurement by tapping the **Start** button.

When the measurement series is finished, the instrument will switch automatically to the next tab.





3. Verify the coating thickness for the standard - enter/make changes: Double-tap the entry field (to the right of "Standard"). On the entry bar at the bottom of the display, tap the numbers/characters in succession (Example: 0 . 4 7 for a coating/ foil thickness of 0.47 µm).

4. Perform 5 measurements on standard #1.

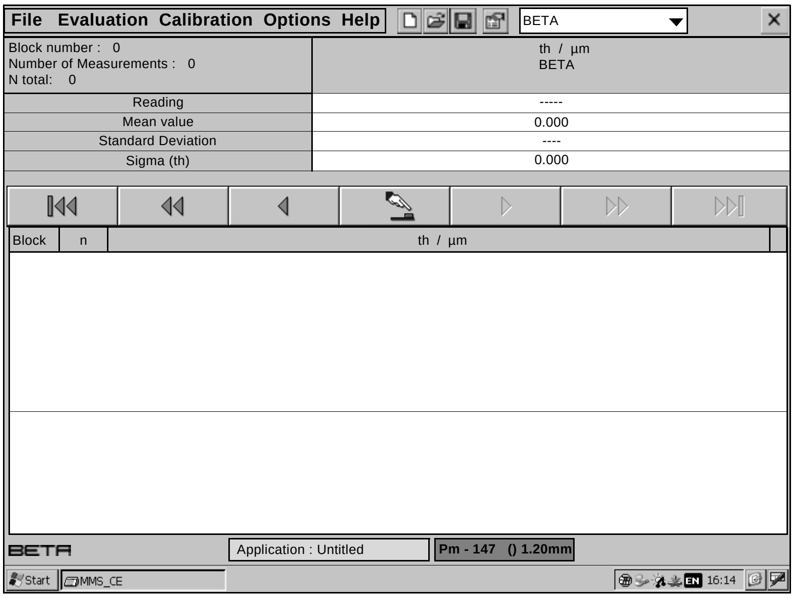
Place the standard anew for each measurement.

Start each measurement with the **Start** button.

5. Repeat steps **6.*3.*** and **6.*4.*** with the additional standards (2, 3, ...). Then continue with step **6.*6.***

6. Tap the **Finished** button using the stylus.

   The *Calibration* window closes.



Measurement mode Numeric Display. Example of a set-up application with the beta source Pm-147 and the aperture platen diameter of 1.2 mm.

Once the calibration is finished, the application (= measurement application file) is set up and it is essentially possible to measure on the specimen.

If the Fischer calibration standard set had been used for the calibration, the measurement system must be adjusted to the substrate and coating materials of the respective specimen! This is done with a so-called normalization. For the procedure, see 3-14.

A density correction may need to be performed, where necessary, 3-21.

Do not forget to save the application! See next page.

3.2.1 Saving a New Application

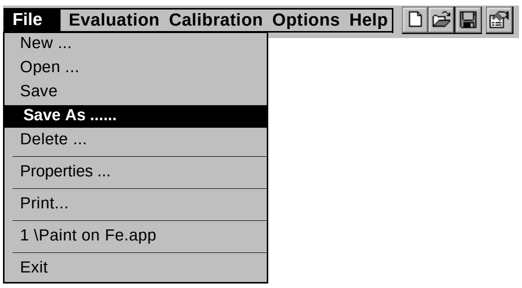
Measurement data, calibrations and additional settings are saved in an application (= measurement application file). To this end, the application must be given a name.

By giving the new application a name, it can be called again and measurement data/settings can be saved under this application name (file name) at any time.

! **Applications that are not saved will be lost when the instrument is switched off! Save the new application first before starting the measurements.**

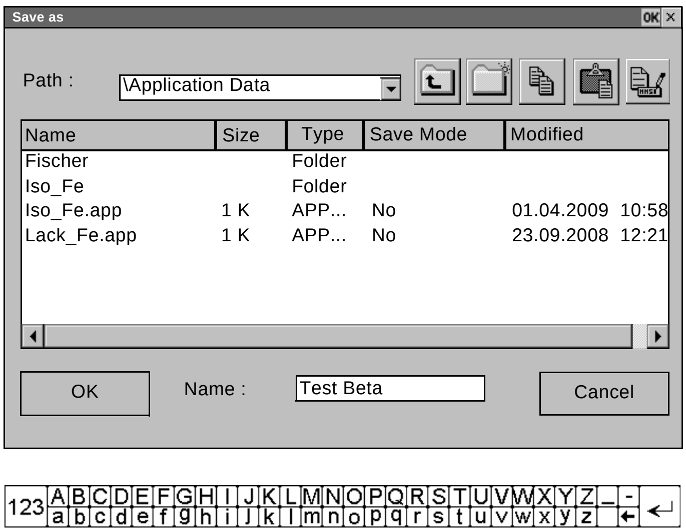
Procedure

1. Calling the window *Save As...*:



Tap **File/Save As ...** on the display in succession using the stylus.

2. Assigning application names:



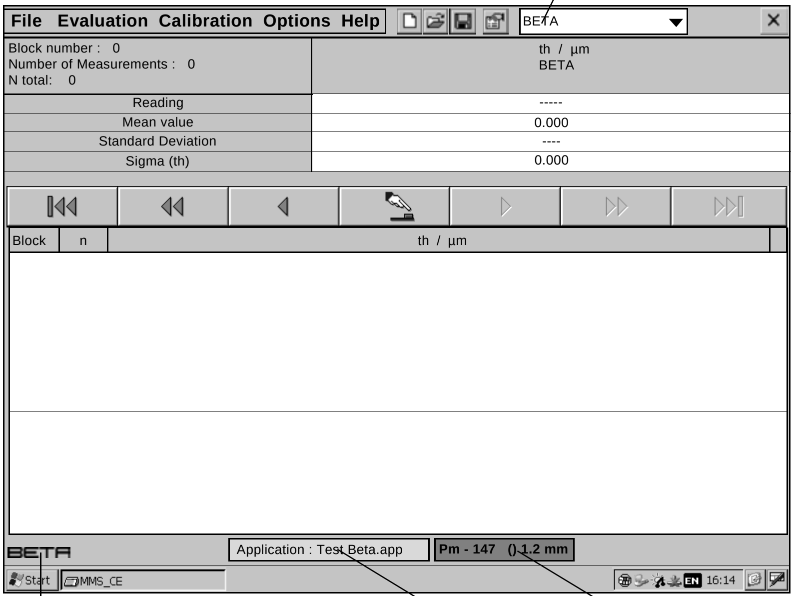
1. **Test Beta** (sample name)
   Tap the letters in succession on the entry bar at the bottom of the display with the stylus.

   If necessary, switch the entry bar to letters/characters: tap the left control area **ABC** or **123**.

2. Tap the **OK** button with the stylus.

   The window *Save As* closes.

Measurement method



Measurement method (Module) Application name used isotope and aperture ring

BETA
Beta backscatter measurement method (DIN EN ISO 3543, ASTM B567)

Example for an application without temperature compensation for measurements using the Pm-147 isotope and a aperture platen opening with a diameter of 1.2 mm.

The newly set up application (= measurement application file) has now been provided with a name (e.g., Test Beta).

All measurements, changes to settings, calibrations or normalizations, etc. in the application "Test Beta" (example) must each be saved anew.

3.3 Application Settings - Measuring Time or Density Factor

Measurement Time

With the beta backscatter measurement method, the measurement accuracy is largely determined by the measuring time (Tmeas) and by the number of measurements (Nmeas). Increasing the measuring time results in an increased measurement accuracy. As a rule of thumb, one can say: Increasing the measuring time by a factor n results in a reduction of the measurement uncertainty by a factor of $\sqrt{n}$. A similar rule applies to the number of measurements.

Typically, measuring times of between 10 and 20 seconds are adequate for a sufficiently high measurement accuracy.

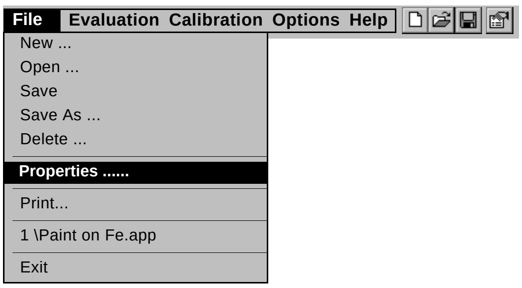
Density Factor

A density correction is required if the coating material of the specimen has a density that is different from that of the standards. This is done using the density factor.

- Calculating the density factor from the quotient of the two coating densities, 3-21.
  In this case, the calculated density factor is accepted automatically into the tab sheet *Beta* and a manual input is not required.
- Direct input of the already known density factor, see subsequent under "Procedure".

Procedure

1. Call the tab *Beta* from the *Properties* window:

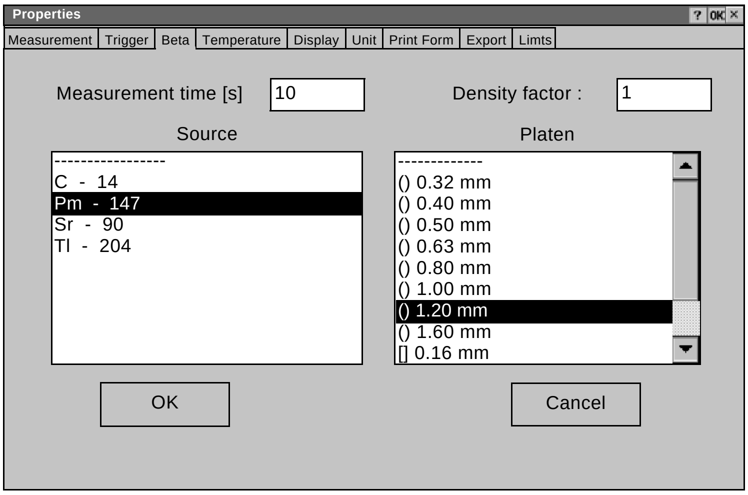


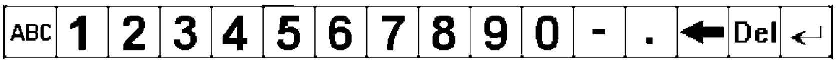
3. **Tap File / Properties...** on the display using the stylus.

The *Properties* window opens

4. From the *Properties* window tap the *Beta* tab.

2. Enter the measuring time / density factor:





1. Double-tap the entry field to the right of "Measurement time [s]" or "Density factor". On the entry bar at the bottom of the display, tap the numbers in succession (E.g., 1 0 for a measurement time of 10 seconds).
2. Confirm the input: Tap the **OK** button using the stylus.

A density factor of 1 means that no density correction is performed.

3. Save the settings in the application: Tap  .

3.4 Application Settings - Changing the Unit of Measurement

For coating thickness measurements using the BETASCOPE® module, the instrument is automatically preset to "µm" (mils) as the unit of measurement. However, it is possible to switch to another unit of measurement for the active application, e.g., "g/m²" for the mass per unit area.

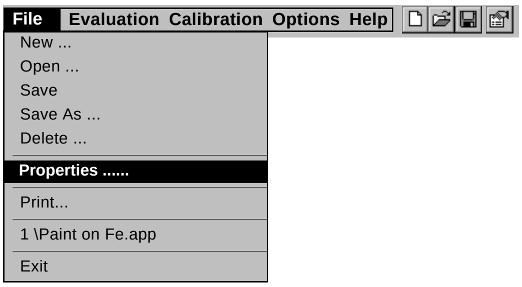
All measurements of the active application will be divided by the entered conversion factor.

If a calibration is performed in "µm" and the measurement is to be carried out in "g/m²" (mass per unit area), the conversion factor "1/density of the coating of the specimen" applies.

If measurements of the mass per unit area are made, it is recommended to perform the calibration in g/m² as well. In this case, the conversion factor equals 1. Thus, only the unit of measurement "g/m²" needs to be entered in the tab *Unit*.

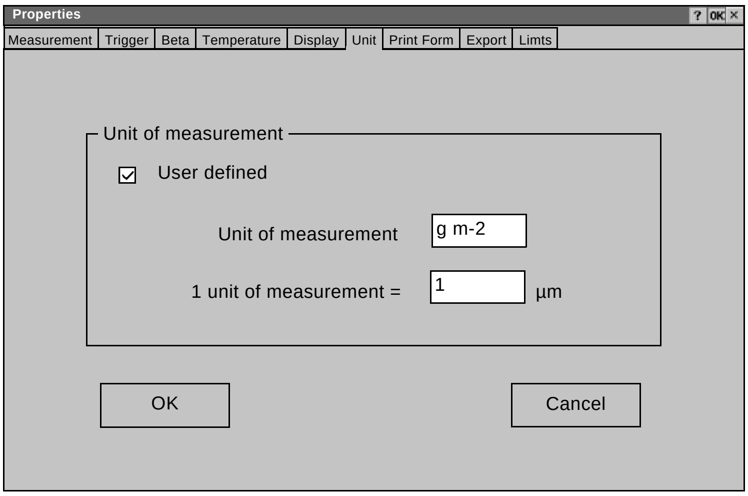
Procedure

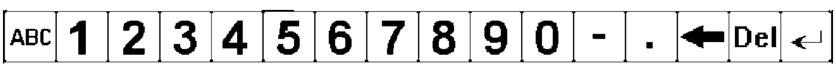
1. Call the tab *Unit of measurement* from the *Properties* window:



1. **Tap File / Properties...** on the display using the stylus.
2. From the *Properties* window, tap the tab *Unit*.

2. Enter the unit of measurement and the conversion factor:





1. Double-tap the entry field to the right of "Unit of measurement" or "1 unit of measurement =". On the entry bar at the bottom of the display, tap the numbers/characters in succession.
2. Confirm the entry: Tap the **OK** button with the stylus.

3. Save the settings in the application: Tap  .

3.5 Influencing Variables Taken into Consideration

With the beta backscatter method, the main variables influencing the coating thickness measurement are:

- Activity of the beta source (isotope)
- Energy of the beta source (isotope)
- Opening of the aperture platen
- Geometric shape of the specimen, e.g., cylindrical shape, wire.
- Composition of the coating materials of the specimen and of the calibration standards.
- Composition of the substrate materials of the specimen and of the calibration standard.
- Density of the coating material of the specimen if it is not the same as the density of the calibration standard coating material.
- The presence of an interim coating.

For correct measurements of the coating thickness, the instrument and the probe, together referred to as the measurement system, must “become familiar” with the specimen (part). This is done using a calibration. The influencing parameters are captured using a reference part and can then be compensated in future measurements. Depending on the required accuracy, the adjustment is performed not only on the substrate and coating materials but also on 1 to 4 coating thickness values using so-called calibration standards. n calibration, we distinguish between normalization and corrective calibration. A normalization or calibration is performed for the respective open application. The correction factors (characteristics) determined in this manner must be stored in the open application.

The normalization or calibration procedure should be performed only with warmed up counter tubes to avoid a drift of the count rate during the warm-up phase. The beta source should, therefore, not be subjected to strong temperature fluctuations! The warm-up phase of the counter tube is 10 to 15 minutes. To this end, connect the beta source/measuring stage to the instrument and switch the instrument on. Cover the beta source with the specimen or the protective cap, or place the beta source on the specimen.

! **A normalization or calibration should always be performed under conditions comparable to those at the specimen!**
The same substrate material and coating material for calibration standards and specimen, the same curvature, etc.!

! **Perform the normalization, or the calibration, with care! It determines the accuracy of the subsequent measurements. - Measurements can never be more accurate than the normalization, or the calibration!**

3.6 Selecting the Calibration Standards

When selecting the calibration standards, it is important to ensure that the materials of the calibration standards correspond to those of the substrate and coating materials of the specimen. If multi-coatings are present, the thickness of the interim coating will determine which material is to be considered the substrate material for the calibration. We are glad to assist you if you have questions in this regard.

Metallic coatings

Creating calibration standards from one’s own production requires significant effort. As a rule, a Fischer calibration standard set can be used. If Fischer calibration standard sets are not available for the required coating/substrate material combination, calibration standards of adjoin elements can be used. However, the differences in substrate and coating materials should only be a few atomic numbers (1 to 3). In such a case, an adjustment to the substrate and coating material of the specimen must be made after calibration (with the Fischer calibration standards) by performing a normalization. If the coating material of the specimen exhibits a density that is different from that of the calibration standard, a density correction must be performed as well. This is done by entering/determining the density factor.

Example: Coating thickness measurement on a brass substrate material (CuZn). The calibration is performed using a nickel calibration standard set (Ni Base), since nickel and brass differ by only one atomic number. A subsequent normalization on brass (uncoated specimen) compensates for the "error" that was made when calibrating on the Ni Base.

For determining the density factor, see page 3-21.

For entering an already known density factor, see page 3-9.

Organic coatings

Synthetic foils (on request) are used as standards for organic coatings such as oil, lacquer, synthetics, photo resist and solder resist.

A density correction must be carried out for the measurement of organic coatings (oil, lacquer) unless calibrations and measurements are made in mass per unit area (g/m²)!
Density correction 3-21.

3.7 Normalization

Necessary

- Compensation of the aperture platen / beta source influences (decrease in activity of the isotope over time due to the beta decay (which cannot be influenced), shape and size of aperture opening).
- If the substrate materials consist of materials with a similar but not the same atomic number as those of the calibration standards, this deviation must be taken into account by a normalization after the calibration (e.g., when setting up a new application).
- With printed circuit boards, a normalization must be performed before making measurements on a new printed circuit board due to the very different compositions of the printed circuit board materials.
- If a measurement is to be made on a strongly curved surface (e.g;., a wire) but the calibration has been performed on flat standards.

Required materials / calibration standards

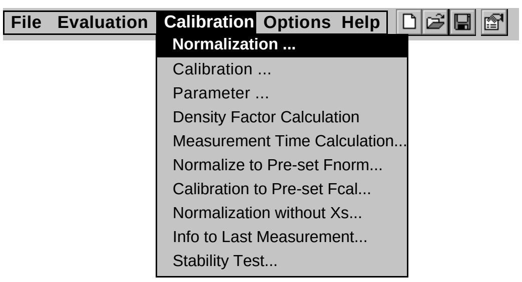
As a rule, parts from the production must be used for the normalization:

- Base: 1 specimen without the coating to be measured or a material of the same shape, thickness and physical properties of the specimen (without the coating to be measured). Possibly a Base from a Fischer calibration standard set.
- Saturation: 1 coated specimen with a coating in saturation thickness (= for the emitter of infinite thickness) or the pure, solid coating material. Possibly ∞-Standard from a Fischer calibration standard set.
  For organic coating materials (oil, lacquer, etc.), a foil (on request) is used.

If the coating material of the specimen exhibits a different density than that of the calibration standard, a density correction must be performed as well, 3-21.

Procedure:

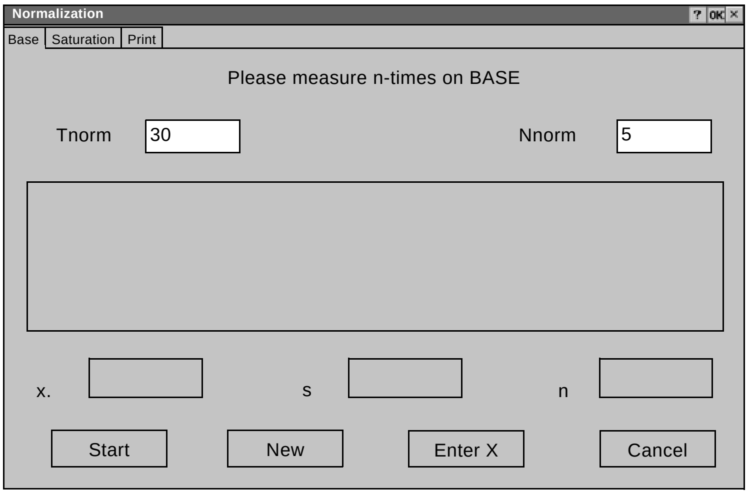
1. Calling the normalization function:

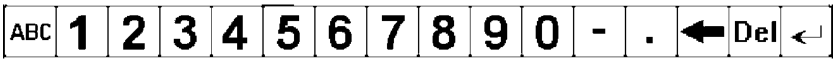


Tap Calibration / Normalization ... on the display in succession using the stylus.

The *Normalization* window opens.

2. Enter the measuring time:



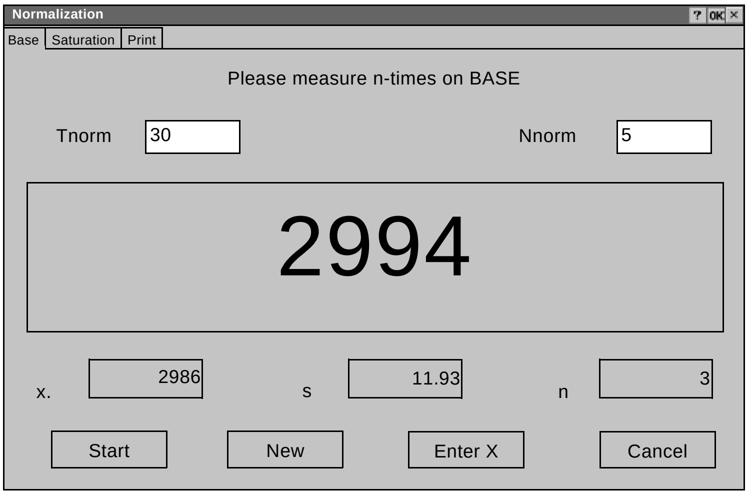


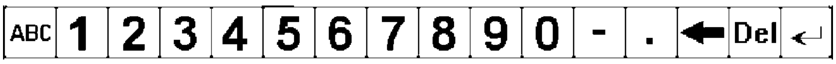
Window *Normalization*

Tap *Base*

Enter a measuring time of 30 seconds: Double-tap the entry field to the right of "Tnorm". On the entry bar at the bottom of the display, tap the numbers in succession (3 0).

3. Material adjustment:





The measuring system must be adjusted to the materials of the specimen.

Base: Specimen without the coating to be measured or Base from the Fischer calibration standard set (e.g., Ni Base).

Saturation: Part consisting solely of the coating material or ∞-Standard from the Fischer calibration standard set (e.g., Au ∞)

After the measurement series is finished. The instrument switches automatically to the next tab!

1. Perform 5 measurements on the substrate material (= BASE).

   Place the Base anew for each measurement. Start each measurement by tapping the **Start** button.

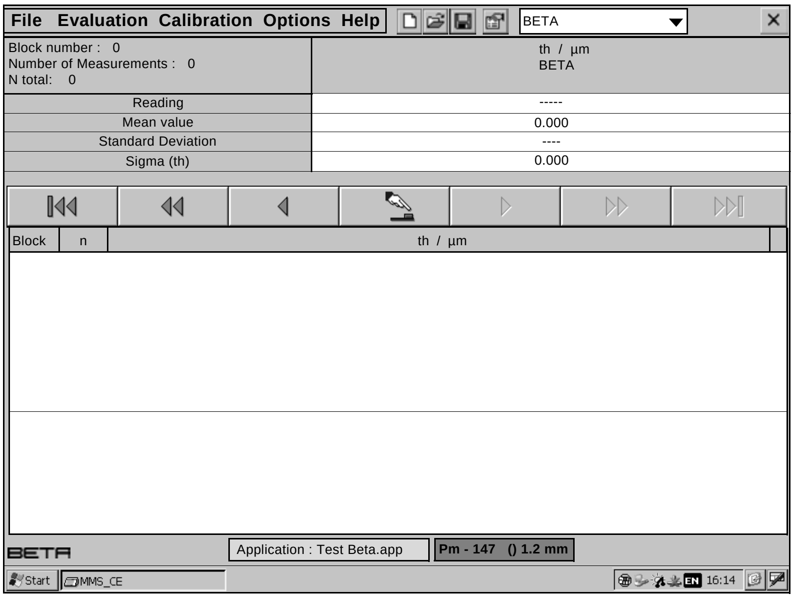
2. Perform 5 measurements on the coating material (= Saturation).

   Place the Saturation anew for each measurement. Start each measurement by tapping the **Start** button.

4. Finish normalization:

Tap the **Finished** button with the stylus.

The *Normalization* window closes.



Measurement mode Numeric Display. Example of a set-up application (without temperature compensation) using the beta source Pm-147 and an aperture platen diameter of 1.2 mm

Actual measurements can be performed once the normalization is finished.

Do not forget to save the application!

Tap the button.

Is a density correction required as well? 3-21.

3.8 Calibration

Necessary

- When setting up a new application (=measurement application file)
- When the count rate drop of the beta source becomes too big (based on comparison measurements)
- When replacing a beta source, or changing the type or shape of the isotope
- When changing or replacing the counter tube

Principally, a new calibration should be performed for every aperture platen / beta source coating/substrate material combination!

With the calibration, the measuring system (beta source and aperture platen) is adjusted to the specimen (coating and substrate materials). During the calibration, not only the backscatter rate of the substrate material (Xo, Base) and of the pure coating material (Xs, Saturation) is determined but also that of 1 to 4 layer thicknesses. Reference parts (calibration standards) with known coating thicknesses are used for this purpose. These reference parts consist of the substrate and coating materials of the specimen. As a rule, the calibration can be performed with Fischer calibration standard sets (on request). For organic coatings, foils are used as calibration standards (on request).

Required materials / calibration standards

- Base: 1 specimen without the coating to be measured or a material with the same shape, thickness and physical properties as the specimen (without the coating to be measured). Possibly a Base from a Fischer calibration standard set.
- Saturation: 1 coated specimen with a coating in saturation thickness (= for the beta source of infinite thickness) or the pure, solid coating material. Possibly a ∞-standard from a Fischer calibration standard set.
  For organic coating materials (oil, lacquer, etc.), a foil is used.
- Standard: Coated reference part where the substrate and the coating materials correspond to those of the specimen. The coating thickness must be known and should be in the range of the coating thickness to be measured. In many cases, a Fischer calibration standard set can be used.

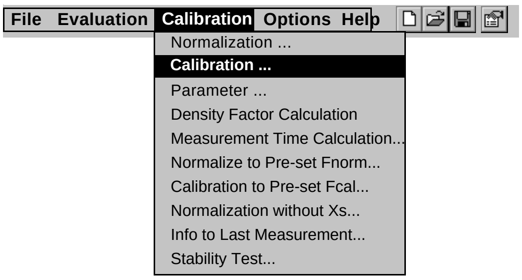
If the substrate or the coating materials differ between the calibration standard and the specimen, an adjustment to the substrate material of the specimen must be carried out after the calibration (with the Fischer standards) using a normalization!

If the coating material of the specimen exhibits a different density than that of the calibration standard, a density correction must be performed as well. This is done with the density factor. 3-21.

If a density value is not available for the coating material of the specimen, the mass per unit area in g/m² can be measured. The unit of measurement in the application must be changed, 3-11, and the calibration must be carried out again in g/m² (mass per unit area of the Fischer standard = Thickness value of the standard (in µm) multiplied with the density value of the coating (g/cm³)). An alternative is the determination of a correction factor through a reference measurement with a different measurement method. The correction factor determined in this manner then takes the place of the density factor, 3-21.

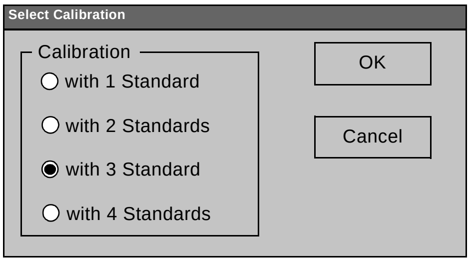
Procedure

1. Calling the calibration function:



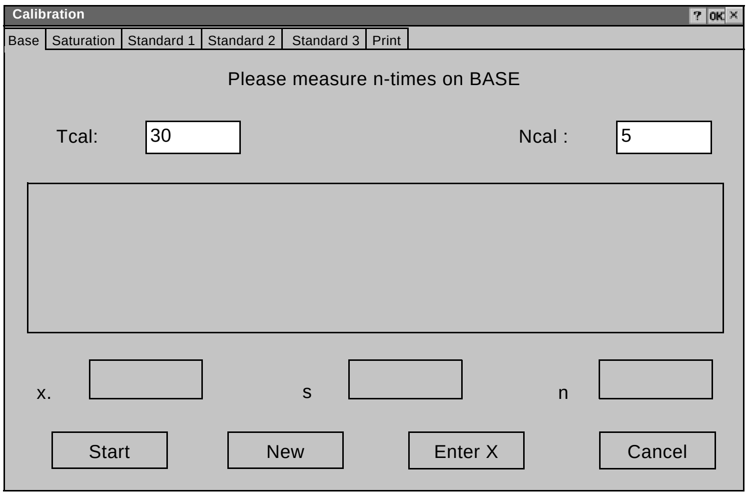
Tap **Calibration / Calibration ...** on the display in succession using the stylus.

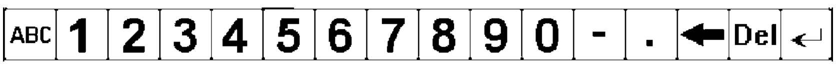
2. Select the number of foils or of <u>coated</u> calibration standards that are available for the calibration.



1. Tap the parameter "with **3 standards**" (Example).
2. Tap the **OK** button with the stylus.
3. The *Calibration* window opens.

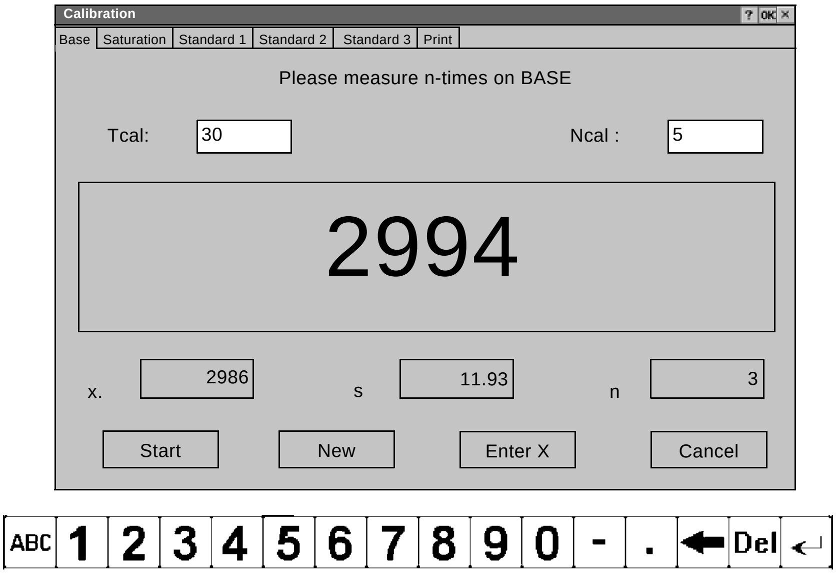
3.





Enter a measuring time of 30 seconds: Double-tap the entry field to the right of "Tcal". On the entry bar at the bottom of the display, tap in succession the numbers (3 0).

4. Material adjustment:



The measurement system must be adjusted to the materials of the specimen.

Base: Specimen without the coating to be measured or Base from the Fischer calibration standard set (e.g., Ni Base).

Saturation: Part made exclusively of the coating material or ∞-standard from the Fischer calibration standard set (e.g., Au ∞)

When the measurement series is finished, the instrument will switch automatically to the next tab.

1. Perform 5 measurements on the substrate material (= BASE).

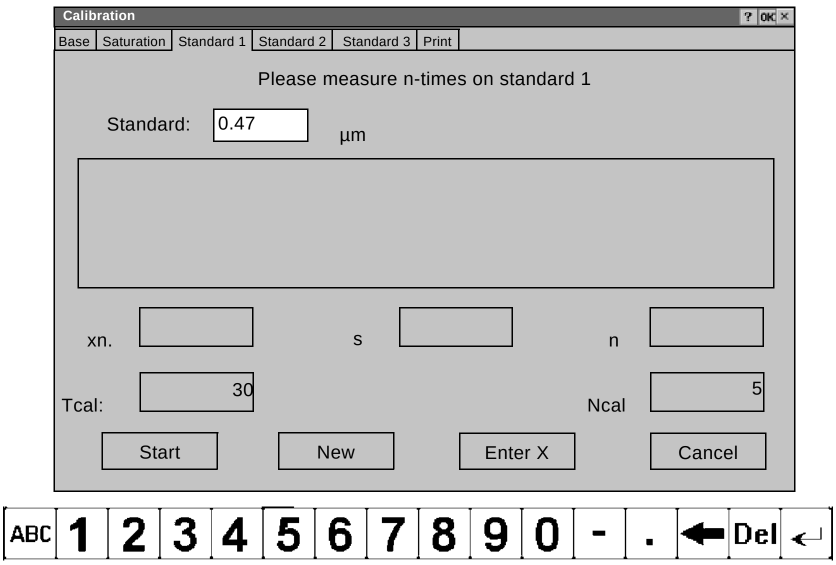
   Place the BASE anew for each measurement. Start each measurement by tapping the **Start** button.

2. Perform 5 measurements on the coating material (= saturation).

   Place the saturation anew for each measurement. Start each measurement by tapping the **Start** button.

3. Verify the coating thickness for the standard - enter / make changes: Double-tap the entry field (to the right of standard). On the entry bar at the bottom of the display, tap the numbers/characters in succession (Example: 0 . 4 7 for a coating/foil thickness of 0.47 µm).

   Note the unit of



measurement!

4. Perform 5 measurements on standard #1.

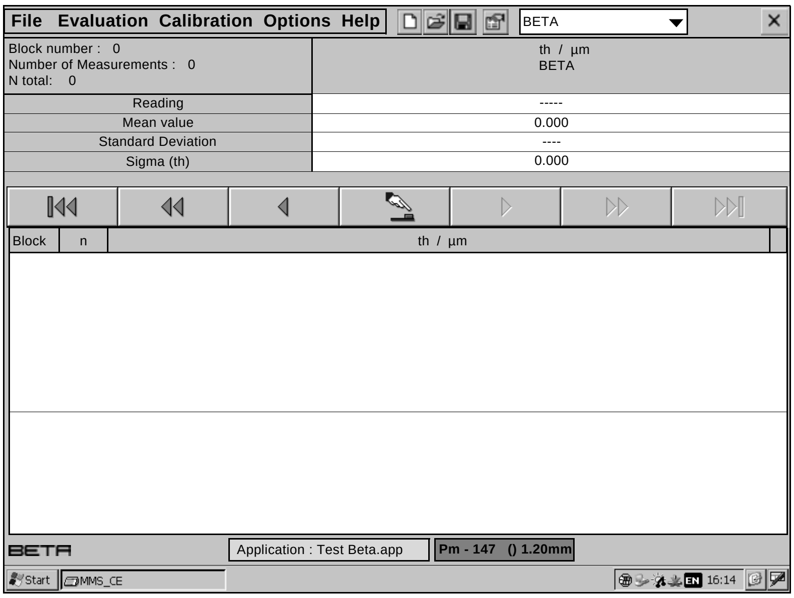
   Place the standard anew for each measurement. Start each measurement with the **Start** button.

Once the measurement series is finished, the instrument switches automatically to the next tab.

5. Repeat steps **4.***3*. and **4**.*4.* with the additional standards (2, 3, ...) Then continue with step **4.***6.*

6. Tap the **Finished** button using the stylus.

   The *Calibration* window closes.



Measurement mode Numeric Display. Example of a set-up application with the beta source Pm-147 and the aperture platen diameter of 1.2 mm.

Once the calibration is finished, the actual measurements can can be made.

If the Fischer calibration standard set had been used for the calibration, the measurement system may need to be adjusted to the substrate and coating materials of the respective specimen! This is done with a normalization. For the procedure, see 3-14.

Do not forget to save the application!

Tap the button.

Is a density correction required? 3-21.

3.9 Density Correction

The coating of each Fischer calibration standard consists of the pure metal or of a metal alloy. Thus, it may occur that the coating of the specimen to be measured has a density that is different from that of the Fischer calibration standard. In such cases, a correction of the density must be carried out after the calibration. The density can be altered by the porosity or by inclusions in the coating material, for example. This influence may be ignored if the coating material is contaminated with elements of similar density and atomic number.

A density correction must be carried out for the measurement of organic coatings (oil, lacquer) unless calibrations and measurements are made in mass per unit area (g/m²)!

The density correction applies only to the active application (file). Other applications set up in the instrument are not affected.

For entering an already known density factor, see page 3-9.

3.9.1 Determination of the Density Factor

With this menu function, the instrument automatically calculates the density factor according to the following equation:

$$\text{Density factor} = \frac{\text{Density of the coating of the standard}}{\text{Density of the coating of the specimen}}$$

Prerequisite for determining the density factor:
The densities of the coating materials of the Fischer calibration standard and of the specimen must be known.

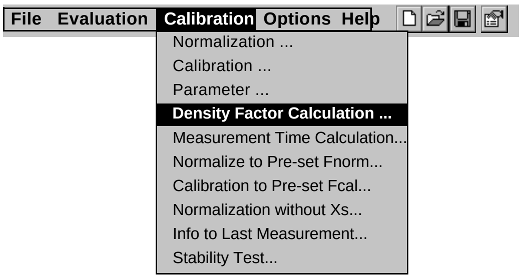
The density of the coating material of the Fischer calibration standard can be taken from the certificate that comes with the calibration standard set.

Alternatives if the density value for the coating material of the specimen cannot be determined:

- Measuring the coating of the specimen with a different measurement method: In this case, the density factor is used as a correction factor for the coating thickness and not for the density. Enter the coating thickness value of the specimen measured with the other measurement method under "Density Standard" and enter the coating thickness value of the Fischer calibration standard under "Density Coating" and calculate the density factor.
- Measuring the mass per unit area (g/m²): This does not require a density correction. No density value for converting the unit of measurement is required either as long as the calibration is carried out in the unit of measurement for the mass per unit area as well.

Procedure

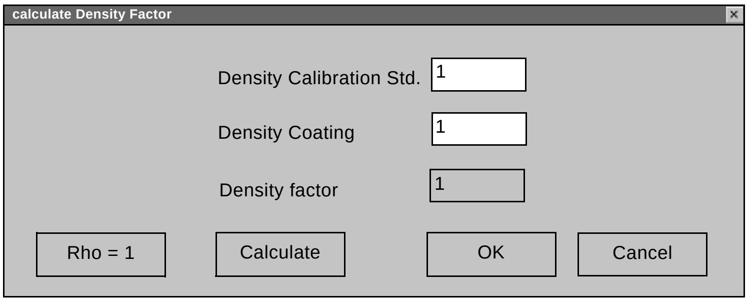
1. Calling the menu function:



Tap **Calibration / determine density factor ...** on the display in succession using the stylus.

The window *Calculate Density Factor* opens

2. Enter the densities of the coating materials:



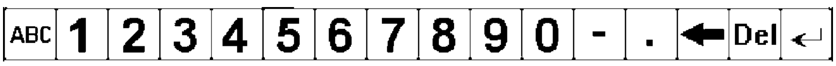
Density Calibration Std.:
Input of the density of the coating material of the calibration standards that have been used for the calibration of the active application.

Density Coating: Input of the density for the coating material of the specimen.

Density factor:
Is calculated automatically by the instrument from the two values mentioned above.

Rho=1:
Resets the density factor to 1. Corresponds to deleting the calculated density factor.

Calculate: Button to start the calculation of the density factor.



Double-tap the entry field to the right of "Density Calibration Std." or "Density Coating". On the entry bar at the bottom of the display, tap the numbers in succession. Use a period as the decimal separator.

3. Calculating the density factor:

Tap the **Calculate** button.

4. Closing the menu function:

Tap the **OK** button.

5. Do not forget: Save the application!

Tap the  button.

The density factor will now be taken into account at every measurement and the measurement corrected according to the density.

3.10 Making Measurements

The instrument measures the backscatter rate of the beta radiation over a certain time Tmeas, converts the backscatter rate into a corresponding thickness value and displays this value.

Before making measurements, the detector (counter tube) requires 10 to 15 minutes to reach its operating temperature. Connect the beta source (measuring stage, hand-held probe) to the MMS® PC2, place the specimen or the protective cover on the beta source (or vice versa, depending on the type of measuring stage, or whether a hand-held probe is used), switch the MMS® PC2 on and wait for 10 to 15 minutes. The detector will then have reached its operating temperature.

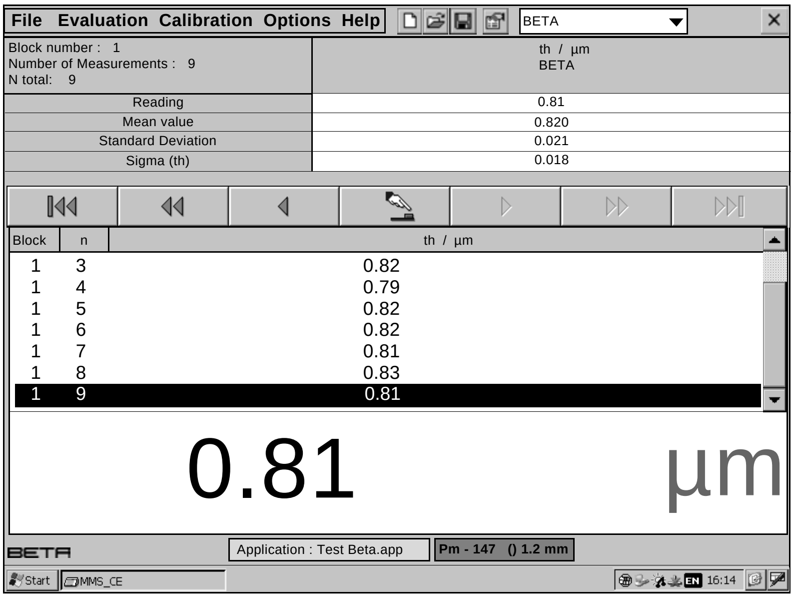
After the warm-up of the counter tube, **check the calibration of the application** that is to be used for the measurement. To this end, perform measurements using a reference part with a known coating thickness. If necessary, perform a new calibration or normalization, 3-12.
Is a density factor in use? 3-9.

- Enter the desired measuring time Tmeas?, 3-9.

- Place the coated side of the specimen on the aperture platen or place the beta source with the aperture platen on the coated side of the specimen, See the next page for examples.

Please also observe the instructions in the operator’s manuals that come with the hand-held probe or with the measuring stage.

- Start the measurement: Tap the button or press the **ENTER** key on the instrument (underneath the display).



Measurement mode Numeric Display, application without temperature compensation, display of the measured quantity with unit of measurement.

- For the next measurement, place the specimen anew on the aperture platen (or vice versa).

Observe the radiation protection ordinance for the use of enclosed beta sources and the instructions for handling beta sources (enclosed with shipment)!

When no measurements are made, always cover the beta source (either with the specimen or with the protective cover)!

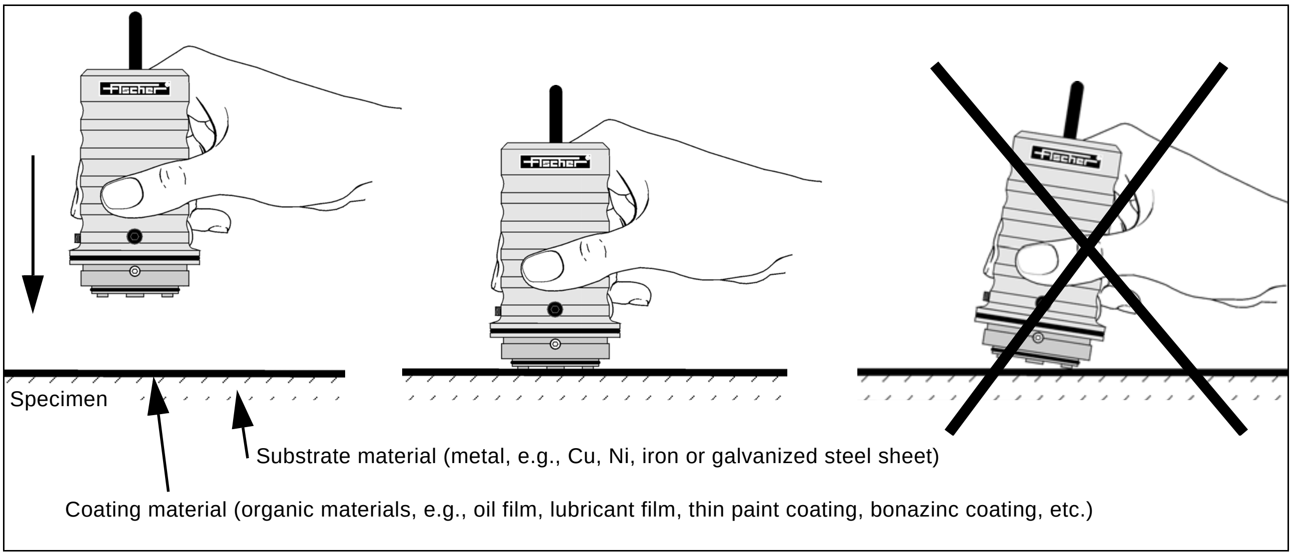
Do not bend the connecting cable for the probe / measuring stage! Doing so may lead to line breaks! The bending radius of the cable should be greater than 5 cm (1.9")!

Making measurements with hand-held probes

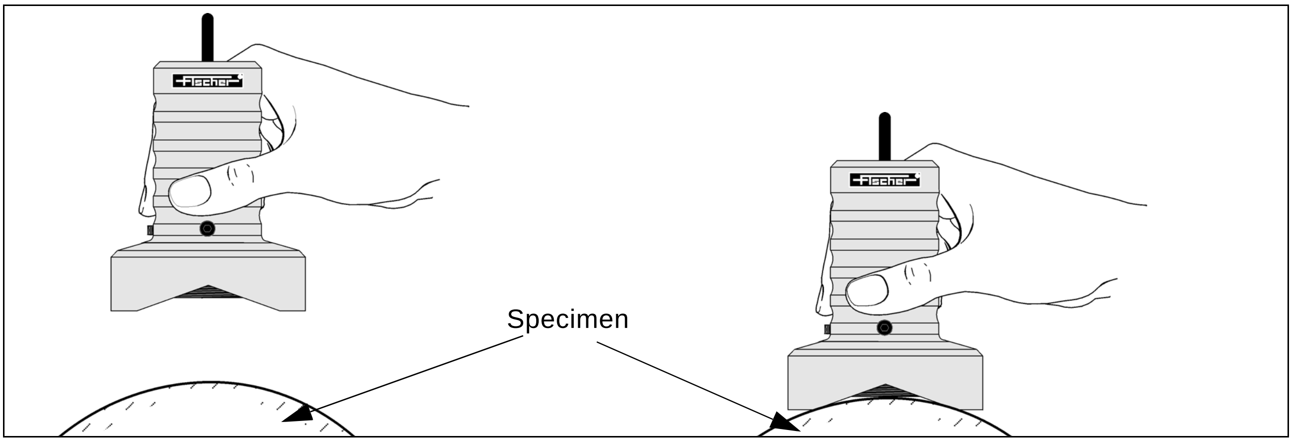
- Always place the probe gently and at 90 degrees to the surface onto the specimen.
- With the default setting, the start of the measurement starts manually by using the  button or the **ENTER** key on the instrument. Measurement accept is automatic and is indicated by a peep sound.
- For the next measurement, lift the probe off the specimen.

When no measurements are made, always cover the beta source (either with the specimen or with the protective cover)!
Never place the hand-held probe on the table or point it at a person!

Making measurements on flat specimens using the hand-held probe model Z15NG

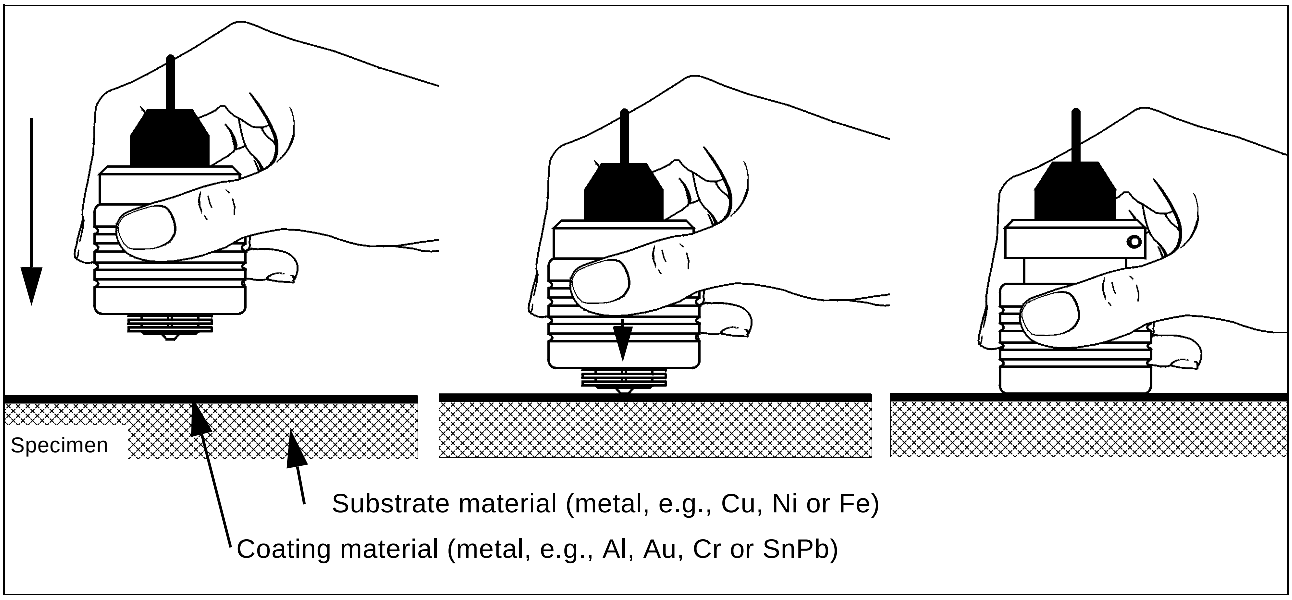


Making measurements on specimens with convex curvatures using the hand-held probe models Z15NG

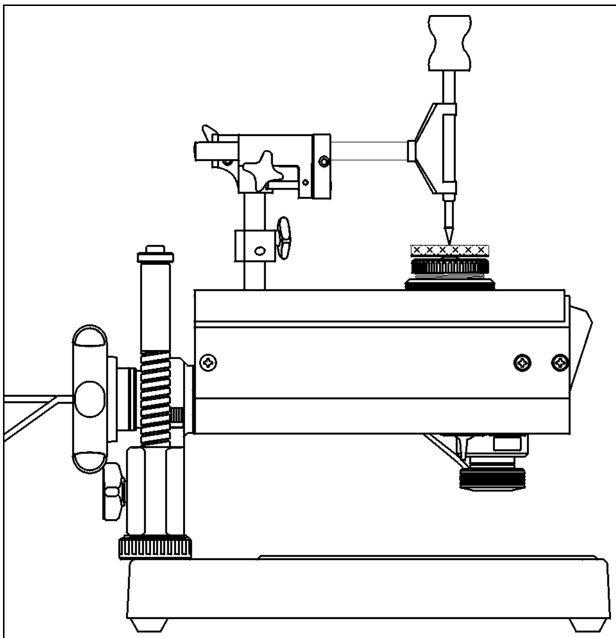


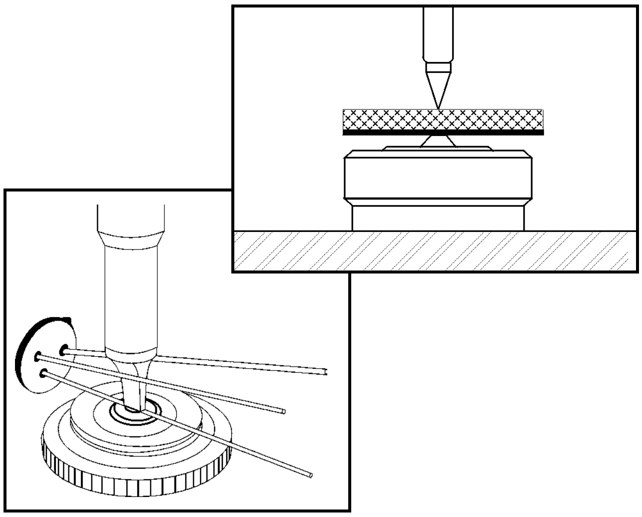
Making measurements on flat specimens using the hand-held probe Z9NG

- Always hold the probe at its grip sleeve.
- Push the grip sleeve to the specimen surface such that the sleeve rests on the specimen surface (Fig. ff.).

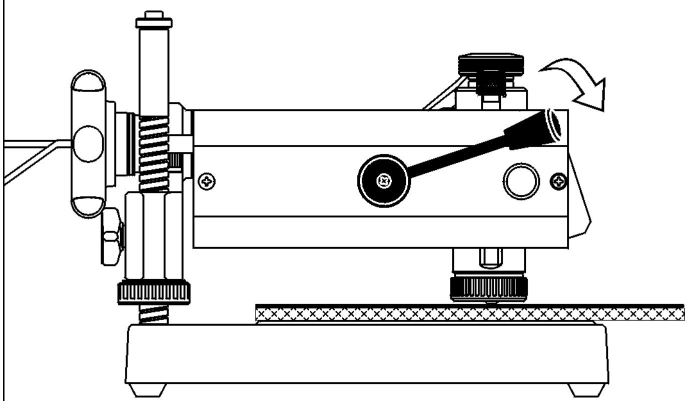


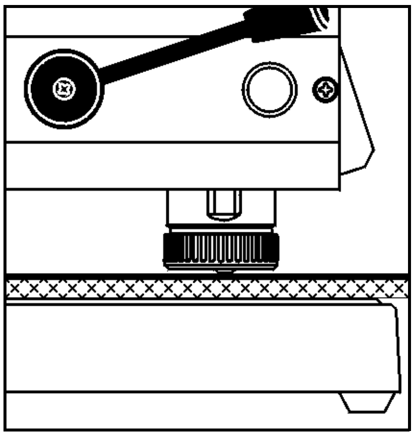
Making measurements on specimens using the measuring stage





Measurements on small parts, shown as an example using the measuring stage Z6NG





Measurement on larger parts using the stage Z6NG

3.11 Making Measurements with Temperature Compensation

This is necessary only when making measurements with the beta source C14 on coating/substrate material combinations that exhibit similar count rates, such as, for example, bonazinc on zinc.

Depending on the ambient temperature, the air absorbs more or less of the backscattered beta radiation. Because of the design of the beta source C14, the backscattered beta radiation has a relatively long path to the counter tube in the air, compared to other beta source models. The beta source C14 is a comparatively low-energy emitter. For this reason, the different radiation absorption in the air, caused by strong temperature fluctuations, is particularly noticeable with this beta source type when making measurements on coating/substrate combinations with similar count rates. Such fluctuations of the absorbed beta radiation can be taken into account with a temperature compensation. Temperature-compensated measurements can be made at any temperature, however, they must be known.

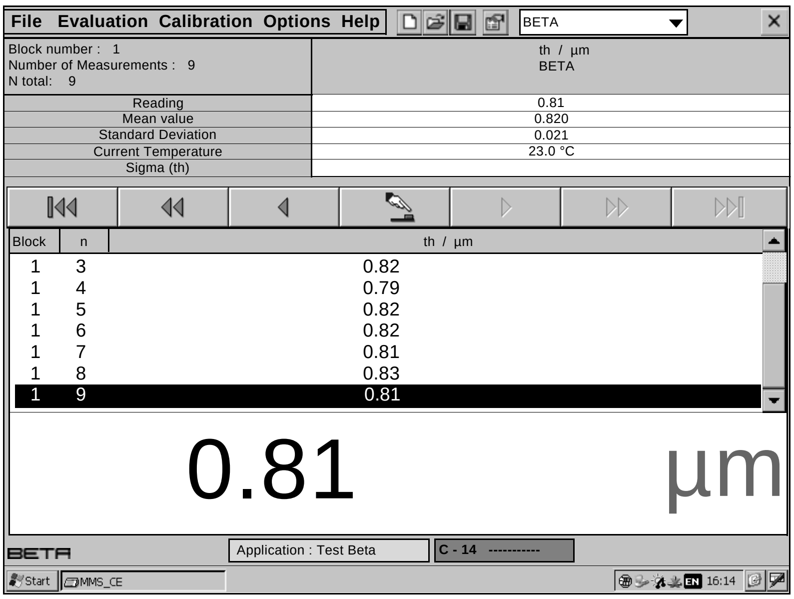
Whether measurements are to be made with or without temperature compensation is defined when setting up an application, 🗐 3-2.

Making Measurements Using the Hand-Held Probe Z15NGA-TC

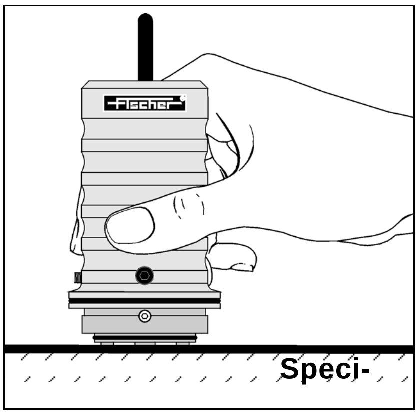
Measurements with automatic accept of the measured temperature.

(Application setting in **File/Properties**, window *Properties*, Tab *Temperature*: Parameter "Automatic temperature correction" is on (check mark visible). Selection is usually made when setting up the application.)

The Z15NGA-TC is suitable for temperature-compensated measurements. The temperature sensor is integrated in the housing of the hand-held probe. With the hand-held probe Z15NGA-TC, the air temperature between the specimen surface and the counter tube is measured continuously during the measurement and used for the temperature compensation.



Measurement mode Numeric Display. Example of an application with temperature compensation, set up for a beta source C14.



Temperature-compensated measurement with the probe Z15NGA-TC

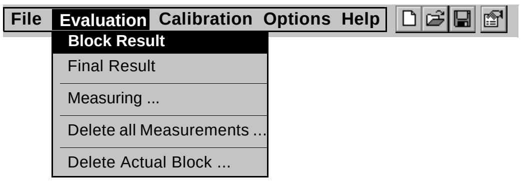
3.12 Evaluation - First Steps

The instrument saves the user from having to do the sometimes complicated and extensive mathematical computations for the statistical evaluation of the measurement data. The evaluation is performed for the respective open application. The measurement data can be displayed and printed in various presentation modes: Listed as characteristic statistical data, in a sum frequency chart, as a histogram and other graphical presentations.

An evaluation of the data measured since the last end of a block is carried out automatically in the background.

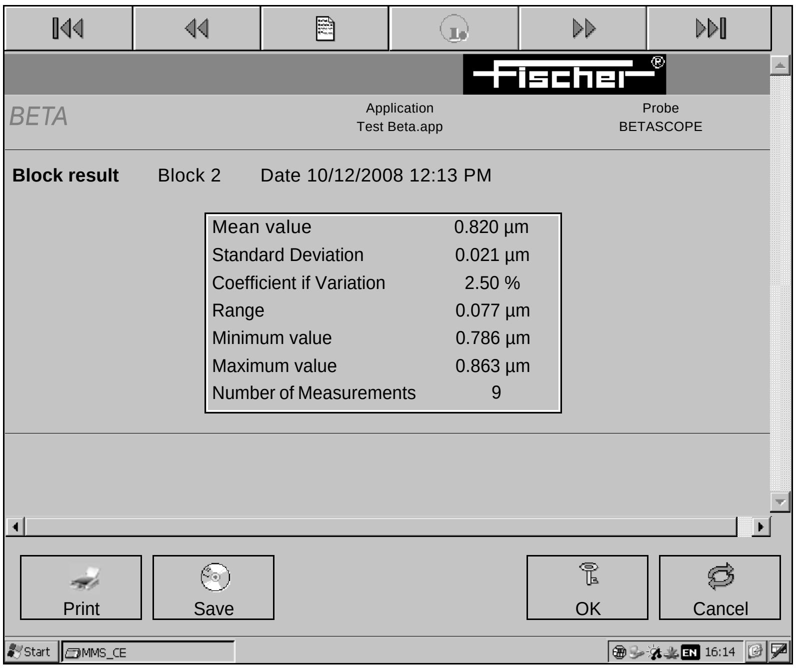
Characteristic statistical data

1. Calling the Block Result menu:



Tap **Evaluation / Block result** on the display in succession using the stylus.

Block result menu (example)



The *Block Result menu* appears on the display.

2. Returning to the measurement mode:

Button **OK**: returning to the measuring mode with closing the block.

or

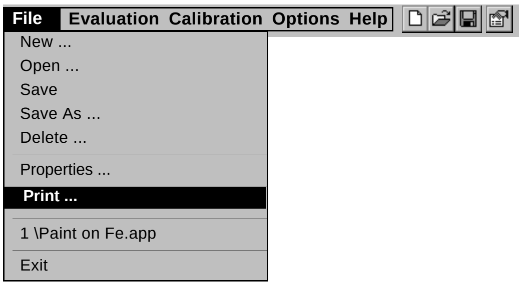
Button **Cancel**: returning to the measuring mode without closing the block.

Print	Printing the block result
Save	Saving the displayed block result in the data formats txt, htm or pdf
:	Scrolling through the blocks.
:	Displays the single readings of the block.
:	No block information available.
:	Shows information of the displayed block.

3.13 Printing

The displayed measurement data or the displayed evaluation can be printed from the Print menu. The printer connected to the MMS® PC2 (USB port) must be switched on for printing. Connecting a printer see chapter "Printing via USB Port", 6-4.

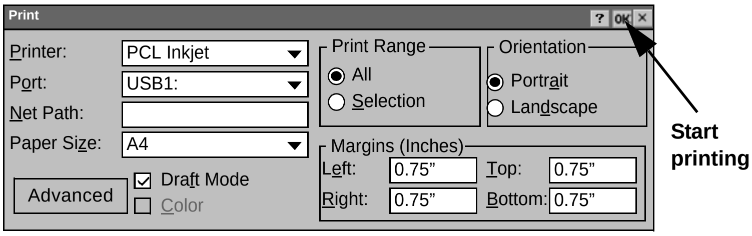
1. Calling the Print menu:



Tap **File / Print...** on the display in succession using the stylus.

The *Print* window opens

2. Set the print parameters in the *Print* window:



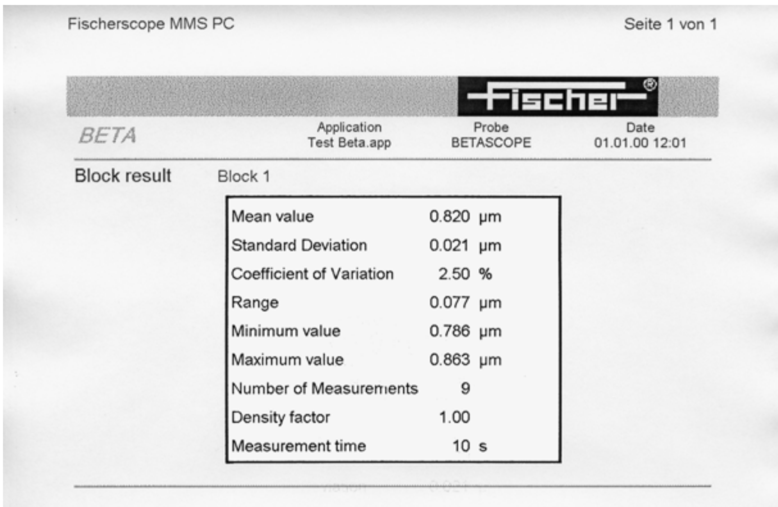
Select the connected printer (type) and the paper format to be used by the printer.

Printer:	Use the table at the end of this chapter to select the proper printer driver.
Port:	Selection of the used port. USB1: when the printer is connected to one of the 4 USB ports.

3. To start printing:

Tap **OK**

in the upper right corner of the *Print* window using the stylus.


Fischerscope MMS PC Seite 1 von 1

Fischer

BETA Application Test Beta.app Probe BETASCOPE Date 01.01.00 12:01

Block result Block 1

Mean value	0.820	µm
Standard Deviation	0.021	µm
Coefficient of Variation	2.50	%
Range	0.077	µm
Minimum value	0.786	µm
Maximum value	0.863	µm
Number of Measurements	9	
Density factor	1.00	
Measurement time	10	s

Printout of the block result of the application Beta Test (example).

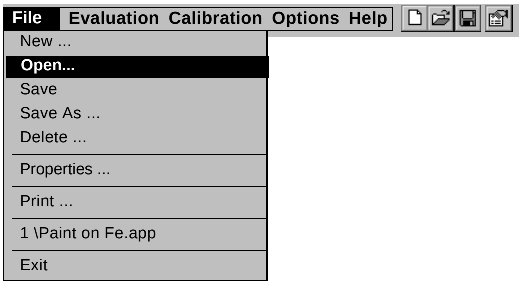
Printer Selection Table

Selectable printer driver (parameter "Printer")	**Printing method and printer type**
EPSON InkJet	all EPSON Inkjet printer
ESCP	all EPSON and other printer with ESC/P printer language emulation
generic Stylus C	EPSON printer series „Stylus C“
generic Stylus Color	EPSON printer series „Stylus Color“
generic Stylus Photo	EPSON printer series „Stylus Photo“
generic Stylus Photo R	EPSON printer series „Stylus Photo R“
PCL Inkjet	all inkjet printer from HP and other manufacturer, which dispose of PCL printer language emulation.
PCL Laser	all Laser printer, which dispose of PCL printer language emulation.
Kyosha Kyoline	Thermal printer of Kyosha, printer FPT 100, distributed from Fischer

3.14 Calling an Application (File)

Procedure

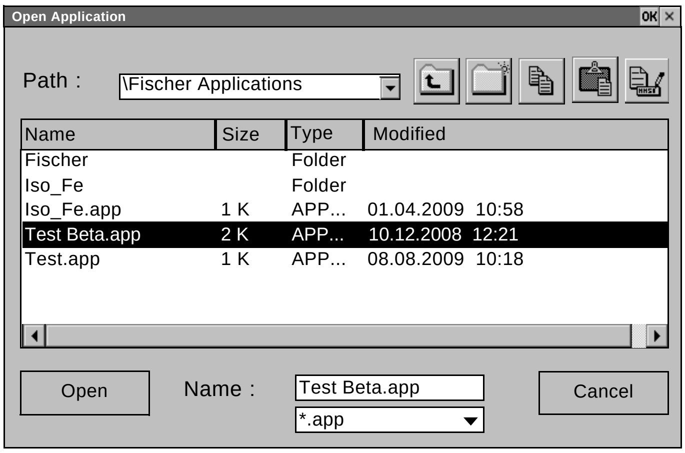
1. Calling the submenu "Open ...":



1. Tap **File / Open ...** on the display in succession using the stylus.

The window *Open Application* appears.

2. Select the desired application file.

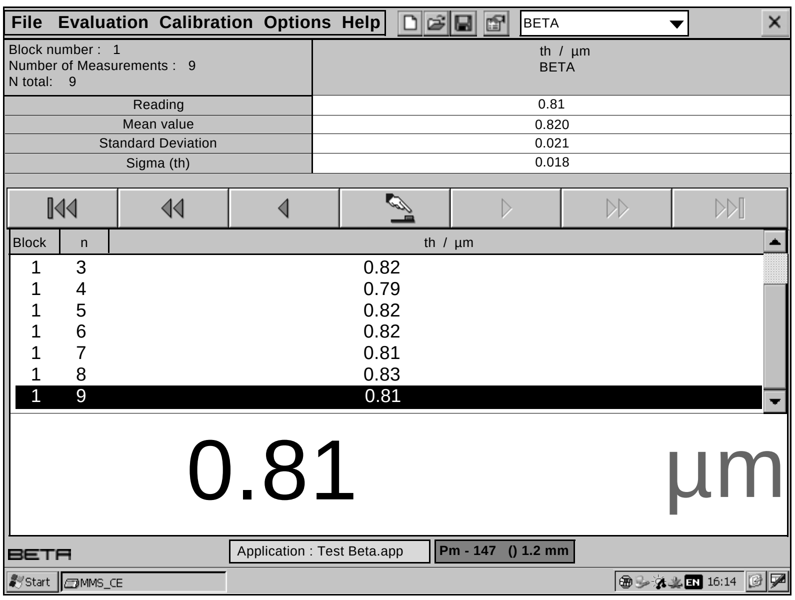


The selected application (file) are color highlighted (example).

Window *Open Application*

If necessary select the required directory. Therefore, tap the button with the stylus to open the directory list. Select the desired directory. Tap the **Open** button with the stylus.

3. Open the selected application file:



Tap the **Open** button with the stylus.

The desired application appears in the display.

Example for an application set up with the beta source Pm-147 and the aperture platen diameter of 1.2 mm .

3.15 Saving an Application File

Tap the button in the application-related toolbar at the top of the display with the stylus.

4 Measurement of the Electrical Conductivity

Measurements with the Module SIGMASCOPE®/PHASCOPE®1

The module SIGMASCOPE®/PHASCOPE®1 includes the phase sensitive eddy current test method according to DIN EN ISO 21968. Well suited for electrical conductivity measurements of non-magnetic metals.

Areas of Application

- Absolute measurement of the electrical conductivity of essentially all non-ferrous metals (titanium to silver).
- Monitoring of hardening processes and heat treatments (e.g., aluminum and aluminum alloys).
- Monitoring of Cu casting procedures - measurement of the phosphorous content for copper.
- Tracking deposition processes (e.g., Cu-Cr alloys).
- Determining the degree of purity of non-ferrous metals.
- Inspecting the homogeneity of non-ferrous metals and alloys.

4.1 The path to Making Measurements

1. Connect the instrument to the line voltage (100 ... 240 VAC, 50 ... 60 Hz) (instrument connector: "+12V/1.2A")

   ! The A/C line voltage must agree with the A/C line voltage rating on the serial number plate of the AC power supply!

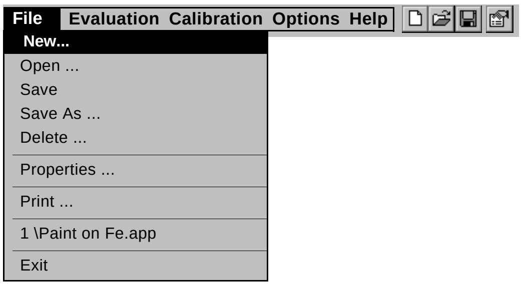
2. Connect the probe to the suitable module socket (module SIGMASCOPE®/PHASCOPE®1).
3. Switching the FISCHERSCOPE® MMS® PC2 On: press the orange **On/Off** key on the front of the instrument.
4. Set up the memory area (file) for the measurement application in the instrument (Setting up an application), 🗐 4-2. / Calling an application (file), 🗐 4-20.
5. Store the application (file) in the instrument, 🗐 4-21.
6. Take influencing variables into account (temperature, specimen curvature, material thickness), 🗐 4-6 .
7. File settings (application settings as probe frequency, temperature compensation, curvature correction etc.), 🗐 4-7.
8. Perform the measurement(s), 🗐 4-11.
9. View/print the evaluation (statistical characteristic quantities, graphical display of the characteristic quantities), 🗐 4-17/4-18.

4.2 Setting Up a New Application (File)

A memory area - the so-called application (file) must be defined before making measurements with the FISCHERSCOPE® MMS® PC2. The probe type used and a few application-specific settings (e.g. used probe frequency) are pre-defined and the measurements are stored in an application file. A measurement application is not only defined by the material properties and the coating / substrate material combination of the specimen but also by the probe type. A new measurement application exists if one of these quantities changes, and a new application must be set. An application contains all data relevant for a measurement application: used probe type (measurement method, serial number of the probe) and settings for the measurement accept, display mode, storage and evaluation of the measurement values (probe frequency, temperature compensation, curvature correction, limit monitoring, block result etc.).

Procedure

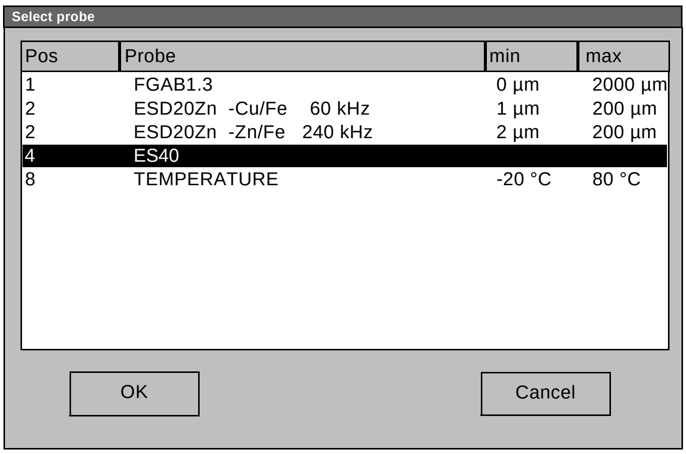
1. Calling the submenu "New ...":



Tap **File / New ...** on the display in succession using the stylus.

The window *Select probe* appears.

2. Selecting the probe:

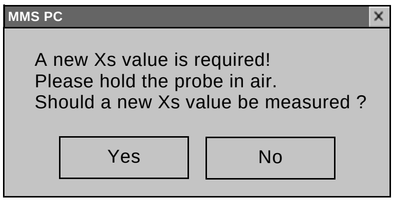


Pos	Plug-in position of the module, where the selected probe is connected.
Probe	Probe name, identical to the name on the probe connector or cable. TEMPERATURE indicates the Temperature module, if mounted in the instrument.
min and max.	Measuring range of the probe

1. Select the probe from the window *Select probe*. Example: Use the stylus to tap ES40 on the display. The selected probe name is highlighted in blue.

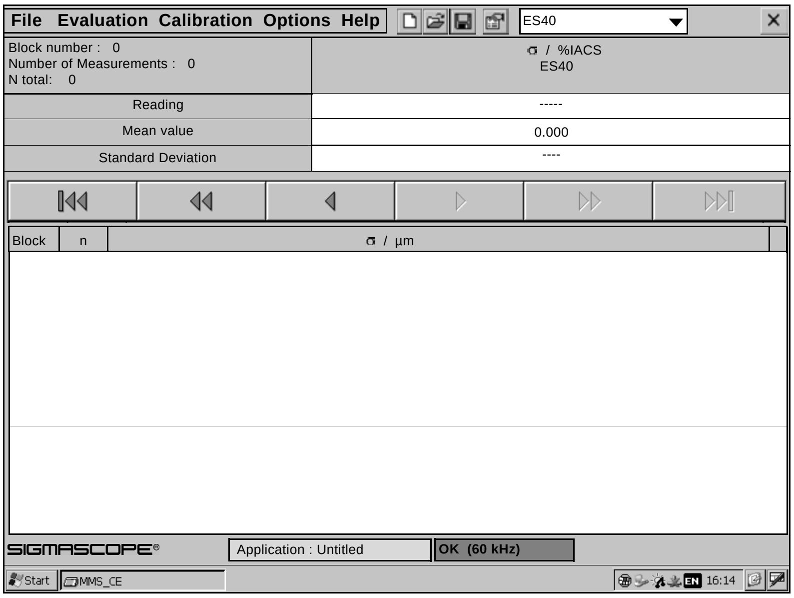
The displayed probe name is identical to the name on the probe connector or cable.

2. Tap the **OK** button with the stylus.



3. Get "air value": Hold the probe in the air (at least 2" (5 cm)) distance to the closest object) and press the softkey **Yes**.

The application is set up (application file) and measurements can be performed on the specimen .



Don't forget to store the application file! 4-4.

Probe frequency: Setting up an application with the ES40 probe the probe frequency of 60 kHz is setting by default. Changing probe frequency 4-7.

Temperature compensation: A new application is setting up by default without temperature compensation. Change the default setting if temperature compensated measurements are required. Changing the setting 4-8.

Curvature correction: A new application is setting up by default with disabled curvature correction. Change the default setting if measurements with curvature correction are required. Enable the curvature correction 4-10.

4. Tap the **Open** button with the stylus.

4.2.1 Saving a New Application (File)

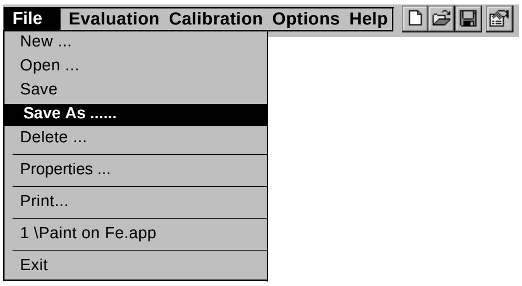
Measurements, calibrations and additional settings are saved in an application (= application memory, file). To this end, the application must be given a name.

By giving the new application a name, it can be called again and measurements/settings can be stored under this application name (file name) at any time.

Applications that are not saved will be lost when the instrument is switched off!

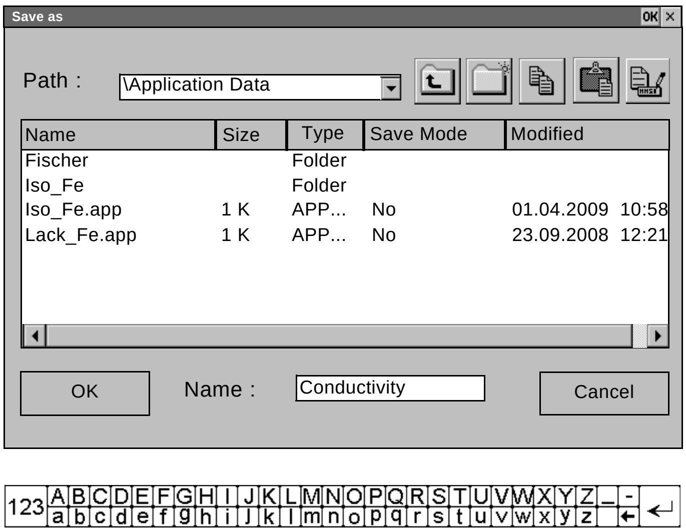
Procedure

1. Calling the window *Save As...*:



Tap **File/Save As ...** on the display in succession using the stylus.

2. Assigning application names:



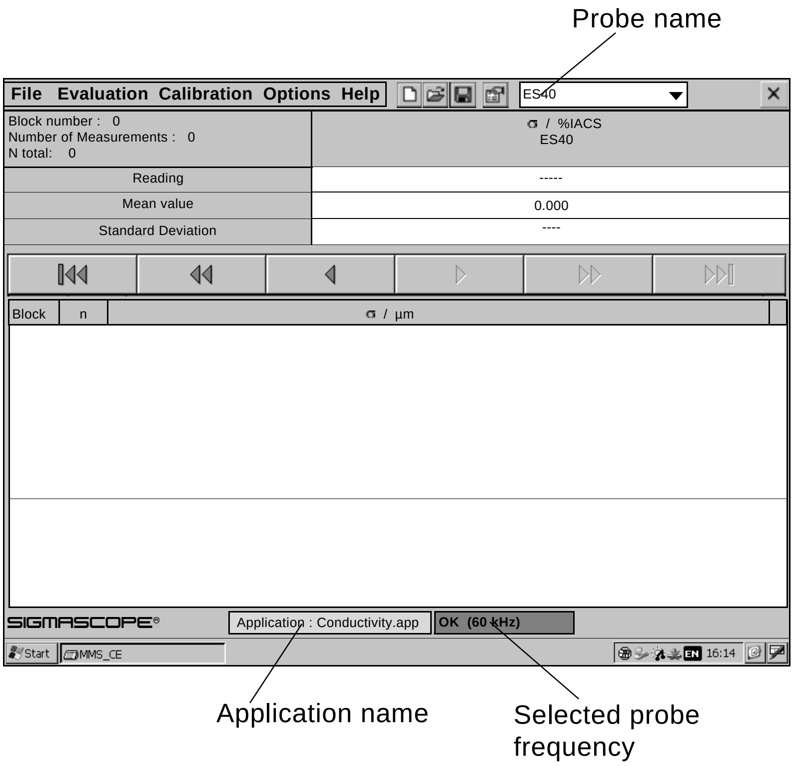
Window *Save As*

1. **Conductivity** (sample name)
   Tap the letters in succession on the entry bar at the bottom of the program window with the stylus.

If necessary, switch the entry bar to characters/letters: tap the left control area **ABC** or **123**.

2. Tap the **OK** button with the stylus.

3. The window *Save As* closes.



Measuring mode Numeric Display. Example for an application setting up with probe ES40 to measure the electrical conductivity with temperature compensation.

The newly set up application (= application memory, file) has now been provided with a name (e.g., Conductivity).

Now, measurements can be made in the application "Conductivity" (example).

The influencing quantities to the measurement of the electrical conductivity should be taken into account! 4-6.

The FISCHERSCOPE® MMS® PC2 contains functions for compensation of these influencing quantities.

If desired, further application specific settings can be made for the current application. - For example the enabling of the temperature compensation or the curvature correction, or selection of the probe frequency. The settings will performed in the application properties, up from 4-7.

4.3 Influencing Variables to the Measurement of the Electrical Conductivity

The geometric shape and the temperature of the specimen influence the measurement when determining the electrical conductivity according to the phase sensitive eddy current method.

4.3.1 Geometric shape of the specimen:

- The **curvature of the specimen surface** should be taken into account using the curvature correction function integrated into the instrument, 4-10. Further information about the curvature correction see appendix, 4-28.
- The specimen must have a **minimum thickness** for a proper measurement. This minimum thickness depends on the probe frequency in use and the material. Further Information see appendix, 4-26.

4.3.2 Temperature of the specimen

The **temperature** of the specimen is the significant **influencing quantity** for the electrical conductivity measurement. This temperature influence can be expressed for each material by the so-called "temperature coefficient of the electrical resistance" (α). Listings of some materials with their temperature coefficients can be found in the respective technical literature (e.g., R. C. Master, P. McIntire, M. L. Mester: Nondestructive Testing Handbook; USA; American Society for Nondestructive Testing).

The physical correlation between the electrical conductivity and the temperature of the specimen is described by the following equation:

$$\sigma = \sigma_{20}/[1 + \alpha\,(T - 20°C)]$$

where:
σ: electrical conductivity in MS/m
σ_{20}: electrical conductivity at +20°C
T: current temperature of the specimen in °C
α: temperature coefficient of the electr. conductivity of the specimen

Example:
For Cu with 58 MS/m at 20 °C, a temperature increase of, e.g., 1 °C (°F) will result in a decrease of the electr. conductivity of 0.23 MS/m, or correspondingly, for 100 %IACS a decrease of 0.4 %IACS.
With a typical repeatability of the readings of 0.2 % of the reading, differences in the specimen temperature of only 0.5 degrees will already be noticeable at the measurement.

The FISCHERSCOPE® MMS® PC2 offers the ability of performing temperature- and curvature-compensated measurements. The decision whether to measure with or without temperature or curvature compensation is made when setting up an application. 4-8.

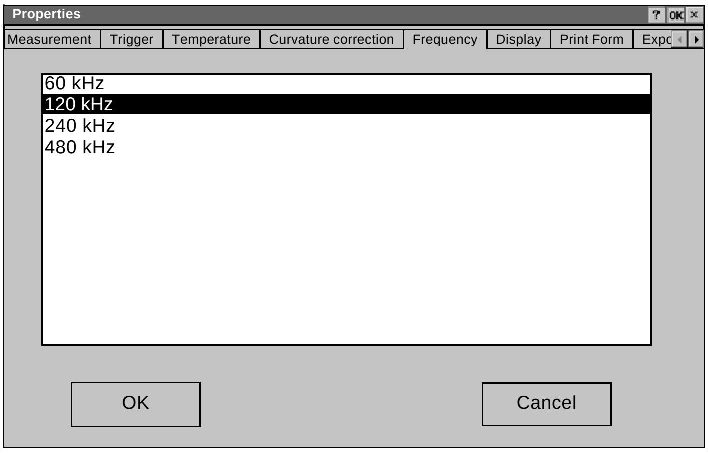
4.4 Application Setting - Probe Frequency for ES40 probe

In general, a probe frequency of 60 kHz will be used for the measurements. For very thin specimens it is recommended to select a higher probe frequency. However, it should be noted that a higher measurement frequency may also entail a higher measurement deviation.

The probe frequency can set only for multi frequency probes, e.g. ES40!
Changing the probe frequency will delete previously obtained measurements in the active application.
Further information about probe frequency and material thickness see appendix, 4-26.

Procedure

1. Calling the tab *Frequency* **of the window** *Properties***:**



1. Tap **File / Properties ...** in the display in succession using the stylus.
2. Tap the tab *Frequency* in the window *Properties*.

2. Select (tap) the desired probe frequency.

The selected probe frequency is highlighted in blue.

3. Tap the OK button with the stylus.

The selected probe frequency is displayed in the green field of the upper program window bar.

4. Don‘t forget to save the application setting: Tap the button with the stylus.

4.5 Application Setting - Temperature Compensation

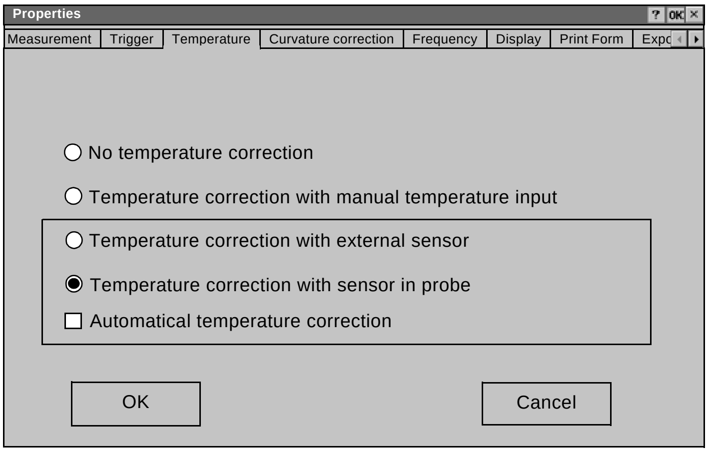
An application can be set to measure the electrical conductivity with or without temperature compensation. Perform the settings in the application properties.

Procedure

1. Calling the tab *Temperature* **of the window** *Properties***:**

1. **Tap File / Properties ...** in the display in succession using the stylus.

2. Tap the tab *Temperature* in the window *Properties*.



The description of the parameter see next page.

Further information about the temperature influencing the measurement of the electrical conductivity see page 4-6.

2. Select type of temperature compensation:

1. Tap the desired parameter.

Default setting: parameter "No temperature correction".

2. Confirm the selection: Tap the **OK** button with the stylus.

3. Don‘t forget to save the application setting: Tap the button with the stylus.

Tab *Temperature* (window *Properties*): description of the parameters

No temperature correction

Measurement of the electrical conductivity without temperature compensation. The influence of the temperature on the measurement is not taken into account. The specimen and the calibration standard must exhibit the same temperature! The measurement should be perfomed at a temperature of 20 °C.

Temperature correction with manual temperature input

The temperature of the specimen or of the calibration standard is entered manually - in the measurement mode, tap the button and enter the respective temperature under the parameter "Current Temperature".

Temperature correction with external sensor

The temperature probe (sensor) connected to the instrument (module SIGMASCOPE®/TEMPERATURE) is used for the temperature measurement.

Temperature correction with sensor in probe

The temperature sensor integrated in the probe (e.g. ES40) is used for temperature measurements.

Automatical temperature correction

☐ = Parameter disabled
The measured temperature (with internal or external sensor) must manually accepted as the measurement temperature - in measurement mode, tap the button and accept the displayed Sensor Temperature as the current temperature of the specimen using the tap **<<Temperature**.

☑ = Parameter enabled
The measured temperature (with internal or external sensor) is automatically accepted as the measurement temperature.

Selecting this parameter is useful only if the temperature sensor is in permanent contact with the specimen.
The instrument continuously accepts the temperature of the temperature sensor, that is, even when the temperature sensor is placed on the table, for example, and has no contact with the specimen. In such a case, the air temperature is used for the temperature compensation! This leads to erroneous readings!

4.6 Application Setting - Curvature Correction

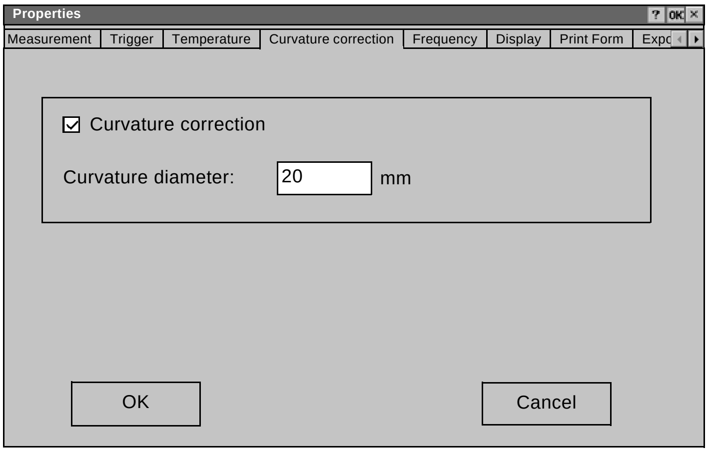
In addition to the temperature, the curvature of the specimen surface influences the measurement. Using the probe type ES40 for measurements the curvature correction can be enabled (disabled by default). Enabling the function in the application properties.

Procedure

1. Calling the tab *Curvature correction* of the window *Properties*:

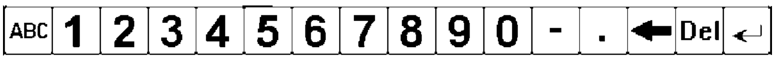
1. **Tap File / Properties ...** in the display in succession using the stylus.

2. Tap the tab *Curvature correction* in the window *Properties*.



Curvature diameter
Entry for the diameter of the surface curvature of the specimen.
Min. entry: 4
Max. entry: 100

Further information about the influencing of the specimen curvature to the measurement of the electrical conductivity see appendix, up from page 4-28.



2. Enable curvature correction: Tap the parameter "Curvature correction".

3. Enter the curvature diameter:

1. Tap in the entry field "Curvature diameter" with the stylus.

2. Enter the desired diameter: Use the entry bar at the bottom of the window, tap the numbers in succession.

! Pay attention of the unit!

3. Confirm the entry: Tap the **OK** button with the stylus.

4. Save application setting: Tap the button with the stylus.

4.7 Enter/Select the Specimen Material or the Temperature Coefficient α

For an exact conductivity measurement, the temperature coefficient (α) of the electrical conductivity of the specimen material must be known in addition to the specimen temperature.

Materials vary in itself in purity and alloy composition. In general is that the reason for unknown temperature coefficient of the material. Because of that the instrument contains a list with the typical temperature coefficients for various materials. For Aluminum and Copper the instrument determines the respectively temperature coefficient.

The known temperature coefficient for the present specimen can also be enter manually with the stylus.

Entering temperature coefficients or selecting the specimen material is possible only for applications that have been set up with temperature compensation, 4-8.

Procedure

1. Calling the entry window:

Tap **Calibration** / **Enter Temperature Coefficient ...** on the display in succession using the stylus.

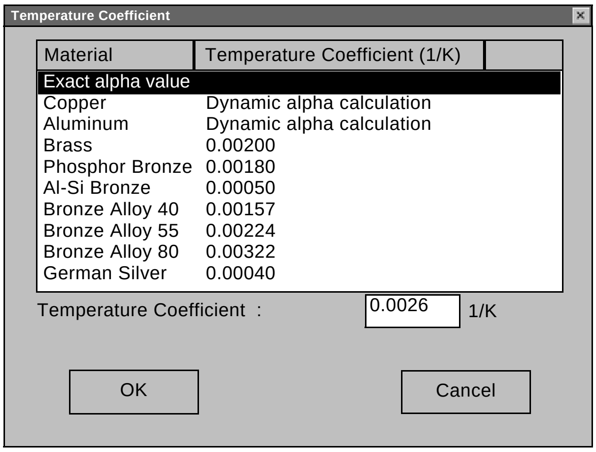
The window *Temperature Coefficient* opens.

2. Select the specimen material or "Exact alpha value".

The latter if the temperature coefficient α is known for the specimen material. To enter the temperature coefficient: Double-tap on the entry field "Temperature Coefficient". Use the entry bar at the bottom of the program window, tap the numbers in succession.

3. Tap the OK button,

to confirm the selection or entry.



Exact alpha Value
The highlighted list parameter enables the manually entry of the temperature coefficient α of the present specimen.
Maximum entry: 0.006 (1/K) or (1/°C)

Material list
Material list with the corresponding typical temperature coefficients α.

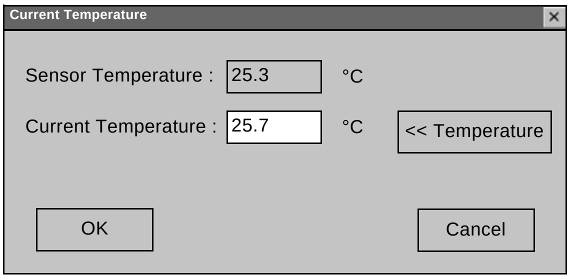
Dynamic alpha calculation
Due to the functional connection between conductivity and temperature coefficient for different aluminum and copper material/alloys the respective temperature coefficient α is computed automatically with the measurement.

Temperature Coefficient
Entered temperature coefficient or displaying the typical temperature coefficient (1/K) of the highlighted material selection. The instrument uses this displayed coefficient for temperature compensation.

4.8 Temperature Capture

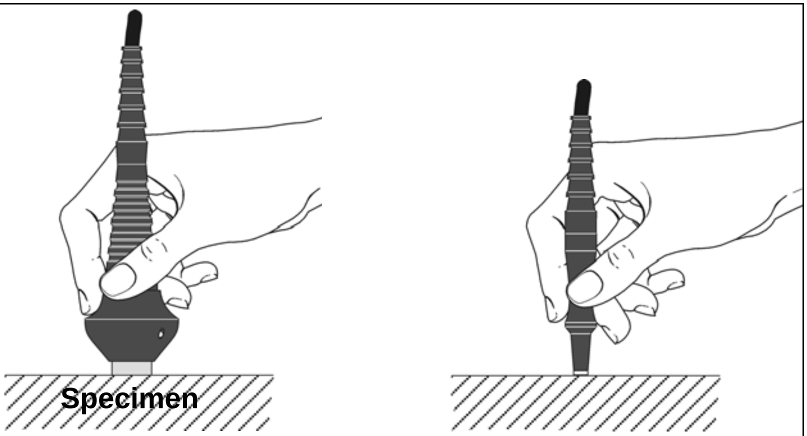
Not used for application set up without temperature compensation.

Procedure



Sensor Temperature
Display of the temperature obtained from the temperature sensor. The parameter is disable for application setting "manually temperature input".

Current Temperature
Temperature used by the instrument to perform the temperature compensation = specimen temperature. Currently measured temperature of the temperature sensor or entry field for manual temperature input.



Temperature capture with the temperature sensor of the ES40 probe

Temperature capture with the temperature probe TF100 A

1. Calling the temperature input window:

Tap the button with the stylus.

The temperature is entered manually or measured with the temperature sensor corresponding to the application settings (**File**/**Properties**, tab *Temperature*).

2. Capture specimen temperature:

- **Enter temperature**: Double-tap on the entry field "Current Temperature". Use the entry bar at the bottom of the program window, tap the numbers in succession.

- **Measure the temperature with temperature sensor**: Place the temperature sensor on the specimen until the sensor temperature is stable. 10 to 20 seconds will generally be sufficient to capture the temperature. Tap the button **<< Temperature** to confirm the sensor temperature.

4.9 Handling of the Probes

Measurements on flat specimens

Fig. 1:
Probe ES40 (example)

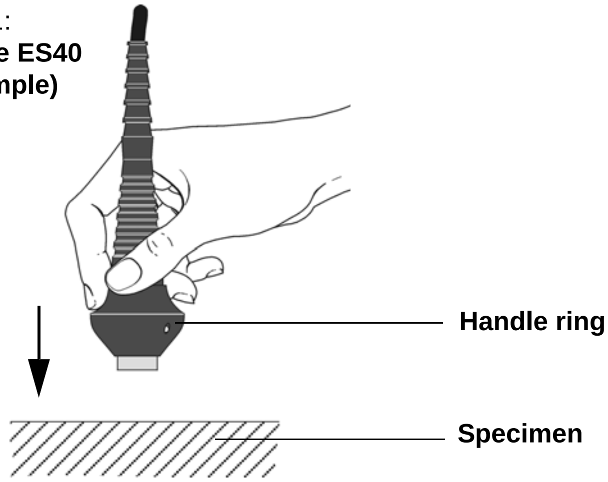
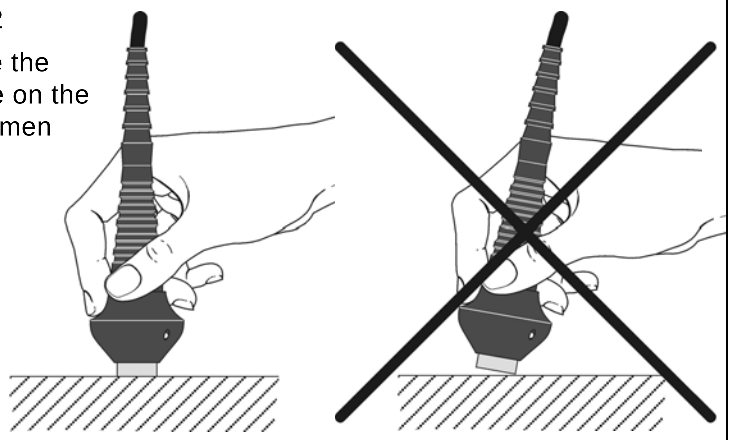


Fig. 2
Place the probe on the specimen



- Always hold the conductivity probe at the handle ring as shown in Fig. 1. The handle ring prevents the heat emission of the hand towards the tip of the probe. In this manner, the heat emission of the hand will not affect the electr. conductivity measurement.
- Always place the probe gently onto the specimen, and perpendicular to the surface (Fig. 2).
- The default setting is automatic measurement capture signaled by a beep.
- Lift the probe at least 5 cm (2") off the specimen before making the next measurement.

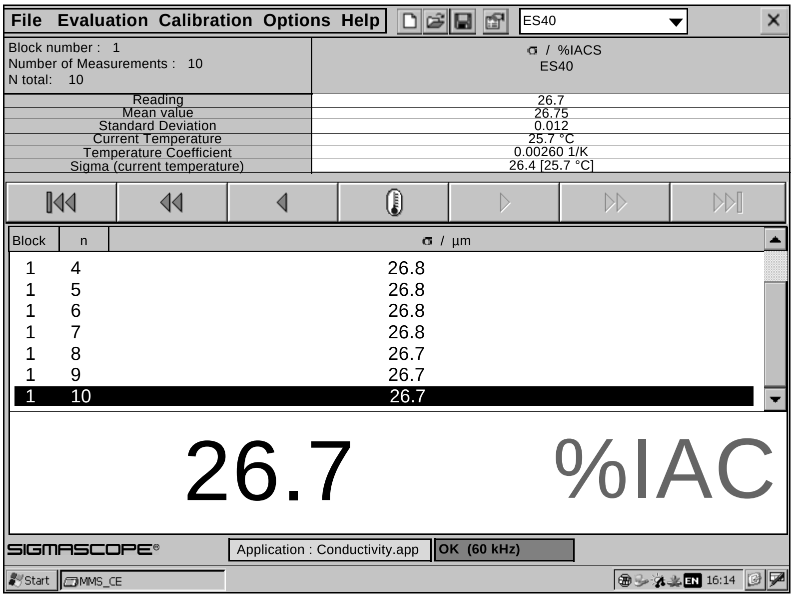
For measurements take the notes for temperature compensation and curvature correction into account, up from page 4-8.

Avoid impacting the probe!

To avoid erroneous measurements, do not allow the probe to float above the specimen!

The instrument can make measurements only in the measurement mode!

Do <u>not</u> bend the probe cable! It may lead to line breaks! The bending radius of the cable should be greater than 5 cm (1.9 inches)!



Measuring mode Numeric Display: The reading is displayed numerically with the unit of measurement.

Measurements on curved specimens

Attaching the attachment prism on the probe see Appendix page4-25.

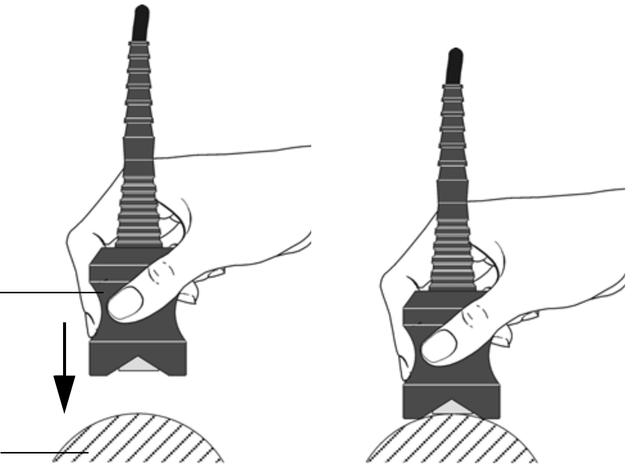


Fig. 4:
Probe ES40
(example)

- Always hold the conductivity probe at the prism as shown in Fig. 4.
  The handle ring prevents the heat emission of the hand towards the tip of the probe. In this manner, the heat emission of the hand will not affect the electr. conductivity measurement.
- Always place the probe gently onto the specimen, and perpendicular to the surface.
- Lift the probe at least 5 cm (2") off the specimen before making the next measurement.

For measurements on curved specimens take the notes for temperature compensation and curvature correction into account, up from page 4-8.

Avoid impacting the probe!

To avoid erroneous measurements, do not allow the probe to float above the specimen!

4.10 Measurement without Temperature Compensation

For correct electrical conductivity measurements without temperature compensation, the specimen and the calibration standards must have the same temperature (±1 °C (°F) according to guidelines of the BOEING AIRCRAFT company). The information concerning the calibration standards always apply to a temperature of +20 °C (+68 °F). That is, for very accurate measurements the specimen must exhibit a temperature of +20 °C (+68 °F).

4.11 Measurement with Temperature Compensation

(Application setting in **File**/**Properties**, tab *Temperature*, 4-8.)

With this variation of the electr. conductivity measurement, the instrument always shows the electr. conductivity reading referenced to +20 °C (+68 °F) in addition to the actual conductivity reading. Using the quantities "temperature of the specimen" and "temperature coefficient of the specimen material" the instrument converts the actual reading to a value referenced to +20 °C +(68 °F) and displays this value (Reading [20 ºC] or [68 °F]). With temperature-compensated measurements, the measurements can be made at any temperatures, as long as it is known.

Enter or confirm manually the measured specimen temperature
During the measurement, check the specimen temperature regularly, and if required, enter the changed temperature described on page 4-12.

Measurement with Manual Temperature Input

Determine the temperature of the specimen with a temperature measuring instrument (thermometer). Enter the measured specimen temperature in the **Temperature Input Menu**.

Measurement with Confirmation of the Measured Temperature

The advantage of this type of temperature-compensated measurement is that the instrument indeed uses the specimen temperature for the temperature compensation. Since the temperature is always taken by the temperature sensor, this type of measurement prevents that, for example, the air temperature taken by the sensor is used for the temperature compensation, because the temperature sensor happens to rest on the table, for example.

Measurement Accepting the Measured Temperature Automatically

This temperature-compensated measurement is suitable for measurement systems, where an external temperature **sensor** is **permanently** connected to the specimen. We recommend to connect an external temperature sensor to the instrument.

Because the temperature is taken continuously by the temperature sensor, it must be ensured that the air temperature taken by the sensor (because the external sensor happens to rest on the table, for example) is not used for temperature compensation.

Before the start of the measurement, ensure that the temperature sensor has taken the specimen temperature, that is, no more significant temperature fluctuations occur.

4.12 Measurement with Curvature Correction

In addition to the temperature, the curvature of the specimen surface influences the measurement. Curvature correction can be enabled when making measurements with the ES40 probe to compensate for the influence of the curvature of the specimen on the measurement result.

Enter the diameter (in mm!) of the surface curvature in the menu **File/Properties**, tab *Curvature correction*, 4-10. Start the measurement.

A curvature correction is possible only in connection with the ES40 probe. This function is not available for the probes ES40HF and ES20.

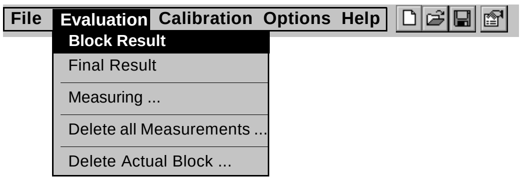
For the ES40HF and ES20 probes, a corrective calibration should be performed on similarly curved reference parts prior to the measurement to compensate for the curvature, Appendix 4-28 .

4.13 Evaluation - First Steps

The instrument saves the user from having to do the sometimes complicated and extensive mathematical computations for the statistical evaluation of the measurement data. The evaluation is performed for the respective open application. The measurement data can be displayed and printed in various presentation modes: listed as statistical characteristic data, in a sum frequency chart or as a histogram.

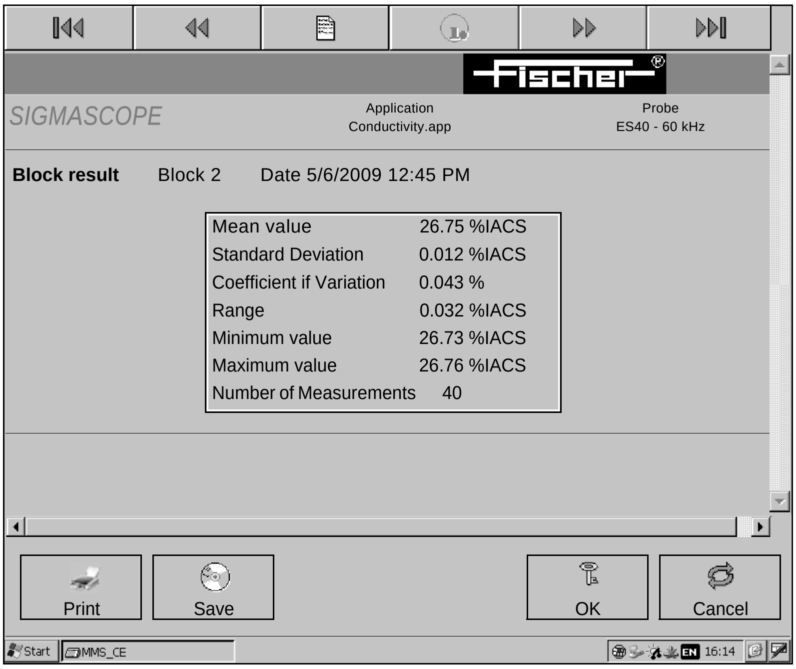
An evaluation of the data measured since the last end of a block is carried out automatically in the background.

Statistical characteristic data



1. Calling the Block Result menu:

Tap **Evaluation / Block Result** on the display in succession using the stylus.



The *Block Result menu* appears on the display.

Print	Printing the block result
Save	Saving the displayed block result in the data formats txt, htm or pdf
⏮ ⏪ ⏩ ⏭:	Scrolling through the blocks.
:	Displays the single readings of the block.
:	No block information available.
:	Shows information of the displayed block.

2. Returning to the measurement mode:

Button **OK**: returning to the measuring mode with closing the block.

or

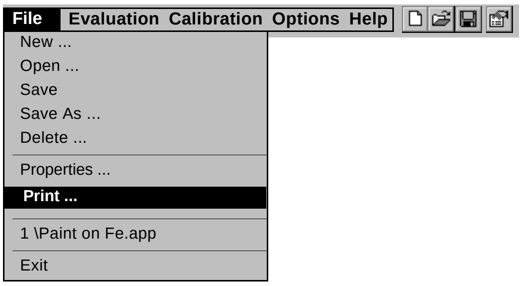
Button **Cancel**: returning to the measuring mode without closing the block.

4.14 Printing

The displayed measurement data or the displayed evaluation can be printed from the Print menu. The printer connected to the MMS® PC2 (USB port) must be switched on. Connecting a printer see chapter "Printing via USB Port", 6-4.

Procedure

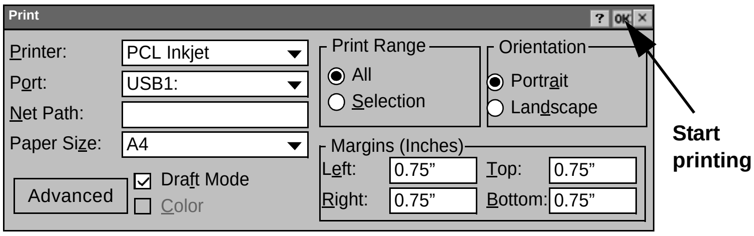
1. Calling the Print menu:



Tap **File / Print...** on the display in succession using the stylus.

The window *Print* opens.

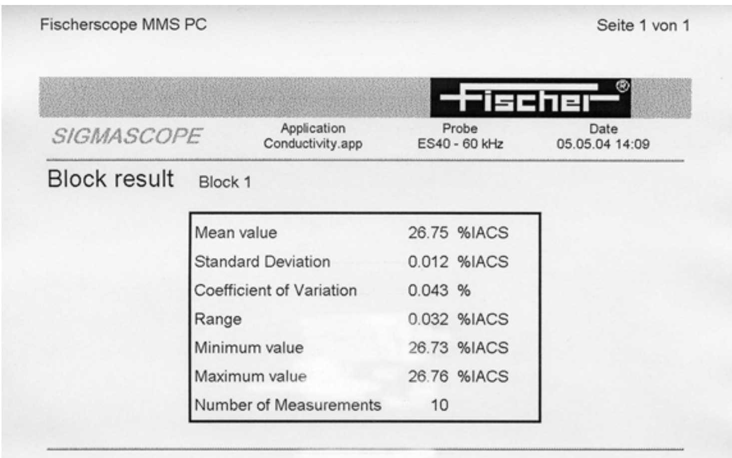
2. Set the print parameters in the window ***Print*****:**



Select the connected printer (type) and the paper format to be used.

Printer:	Use the table at the end of this chapter to select the proper printer driver.
Port:	Selection of the used port. USB1: when the printer is connected to one of the 4 USB ports.

3. To start printing: Tap **OK** in the upper right corner of the window *Print* with the stylus.


Fischerscope MMS PC Seite 1 von 1

Fischer

SIGMASCOPE

Application	Probe	Date
Conductivity.app	ES40 - 60 kHz	05.05.04 14:09

Block result Block 1

Mean value	26.75	%IACS
Standard Deviation	0.012	%IACS
Coefficient of Variation	0.043	%
Range	0.032	%IACS
Minimum value	26.73	%IACS
Maximum value	26.76	%IACS
Number of Measurements	10	

Printout of the block result of the application ‘Conductivity’ (example).

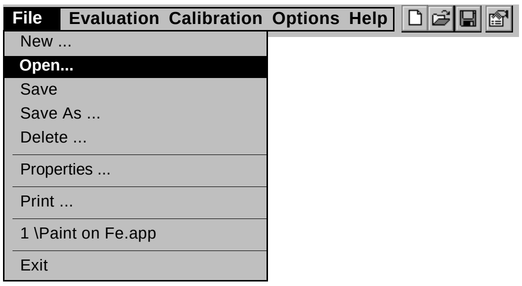
Printer Selection Table

Selectable printer driver (parameter "Printer")	**Printing method and printer type**
EPSON InkJet	all EPSON Inkjet printer
ESCP	all EPSON and other printer with ESC/P printer language emulation
generic Stylus C	EPSON printer series „Stylus C“
generic Stylus Color	EPSON printer series „Stylus Color“
generic Stylus Photo	EPSON printer series „Stylus Photo“
generic Stylus Photo R	EPSON printer series „Stylus Photo R“
PCL Inkjet	all inkjet printer from HP and other manufacturer, which dispose of PCL printer language emulation.
PCL Laser	all Laser printer, which dispose of PCL printer language emulation.
Kyosha Kyoline	Thermal printer of Kyosha, printer FPT 100, distributed from Fischer

4.15 Calling an Application

Procedure

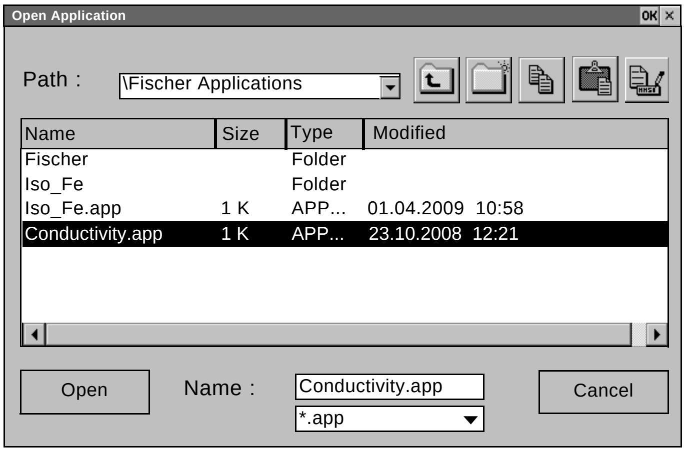
1. Calling the submenu "Open ...":



1. Tap **File / Open ...** on the display in succession using the stylus.

The window *Open Application* appears.

2. Select the desired application file.



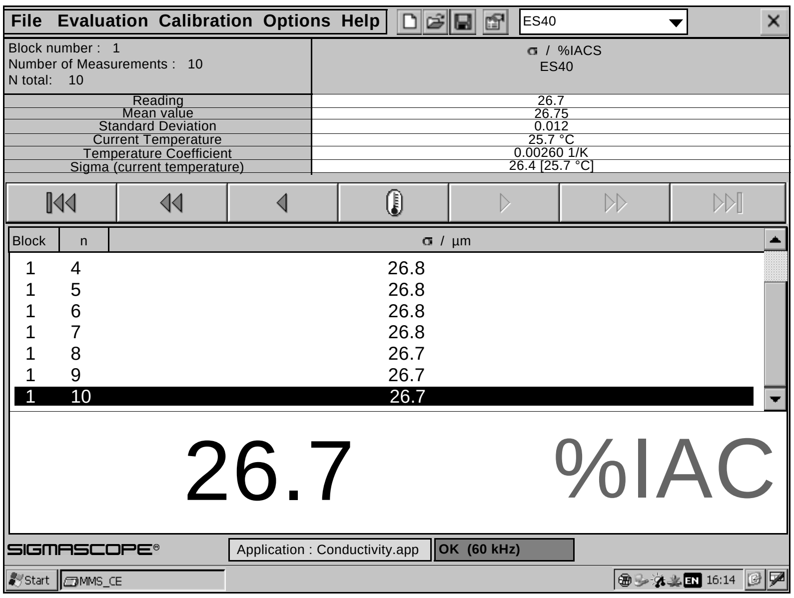
The selected application (file) are color highlighted (example).

Window *Open Application*

If necessary select the required directory. Therefore, tap the button with the stylus to open the directory list. Select the desired directory. Tap the **Open** button with the stylus.

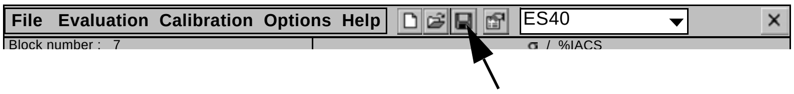
1. Tap the **Open** button with the stylus.

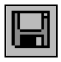
The desired application appears in the display.



Example for an application set up with the probe ES40 with 60 kHz probe frequency and temperature compensation.

4.16 Saving an Application File



Tap the  button in the application-related toolbar at the top of the display with the stylus.

4.17 Appendix

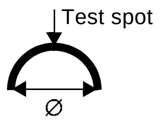
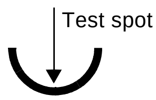
This chapter contains additional descriptions of the influencing parameters to the measuring of electrical conductivity. Furthermore, you will find correction tables for measured conductivity values on specimens with a shallow material thicknesses (< th_{min}) and with convex curvatures as well as for plated aluminum materials according to BOEING Specification BAC 5651.

Appendix, Table of Contents

4.17.1 Probe Specifications

Probes for electrical conductivity measurement

Probe type	ES40	ES40HF	ES20	ES24
Application	electrical conductivity of non-ferromagnetic metals			
Probe/measurement frequency	60, 120, 240, and 480 kHz	1250 kHz	240 kHz	480 kHz
Probe length	130 mm (5.12")		95 mm (3.75")	80 mm (3.15")
Probe diameter	18 mm (0.71"), with handle ring 35 mm (1.38")		16 mm (0.62")	8 mm (0.32")
Probe tip diameter	flat, 14 mm (0.59")		5.5 mm (0.22")	3.3 mm (0.13")
Integrated temperature sensor	Pt 100, class B, permissible deviation according to DIN IEC 751		-	-
Measurement range electrical conductivity	0.5 ... 108 %IACS or 0.3 ... 63 MS/m			5 ... 108 %IACS 3 ... 63 MS/m
Measurement range temperature	- 10 ... +50 °C (+14 ... +122 °F)		-	-

Probe type	ES40	ES40HF	ES20	ES24
Application	electrical conductivity of non-ferromagnetic metals			
*Repeatability precision referenced to Fischer Standards; standard temperature on pre-calibration at 20 °C (68 °F)	≤ 0.10 %IACS / 0.06 MS/m (60 kHz) ≤ 0.15 %IACS / 0.09 MS/m (120 kHz) ≤ 0.20 %IACS / 0.12 MS/m (240 kHz) ≤ 0.35 %IACS / 0.20 MS/m (480 kHz)	≤ 0.5 %IACS or ≤ 0.3 MS/m		≤ 1 %IACS or ≤ 0.58 MS/m
*Trueness (el. conductivity): (referenced to Fischer Standards after pre-calibration at +20 °C (68 °F))	≤ 1 % of nominal value for 1 ... 100 %IACS or 0.6 ... 58 MS/m)			≤ 4 % of nomonal value for 1 ... 100 %IACS or 0.5 ... 58 MS/m
Trueness (temperature)	± 0.8 °C (°F) with +20 °C (+68 °F) ambient temperature		-	-
Distance compensation	up to 700 µm (28 mils) (max. error: 5 % of reading)	up to 500 µm (20 mils) (max. error: 3 % of reading)	up to 350 µm (14 mils) (max. error: 1 % of reading)	up to 200 µm (8 mils) (max. error: 3 % of reading)
Min. Material thickness th_{min} for error ≥ 10 %	$th_{min} = 2{,}5 \cdot \frac{503}{\sqrt{f \cdot \sigma}}$ *mm* (σ in MS/m and f in Hz)			
Influence of curvature, 4-28 *  Ø for ≥10 % measurement deviation at the master calibration on flat	⌀ < 18 mm (0.71") (for Al with 50 %IACS or 29 MS/m) Probe suitable for measurements with curvature correction enabled.	⌀ < 20 mm (0.79") (for Al with 50 %IACS or 29 MS/m)	⌀ < 18 mm (0.71")	⌀ < 7 mm (0.27") (for Al with about 30 %IACS or 17.4 MS/m)
* 	Measurement not recommended.			
*Influence of edge No influence at specified ⌀, if probe centered placed on the specimen.	⌀ > 11 mm (0.43")		⌀ > 12 mm (0.47")	⌀ > 7.2 mm (0.28")
Measurement application for Master Calibration	Performed at time of delivery with 8 standards of the Fischer master calibration set, traceable to electrical conductivity calibration sets of Boeing set no. B8-88-326-x and Zetec set no. 1555-x.			

* The specifications only be valid for probes master calibrated together with the used instrument.

Temperature Probe

	SMP10-TF
Application	Measurements of temperatures on metal surfaces
Measurement range	-20 ... +80 °C (-4 ... +176 °F)

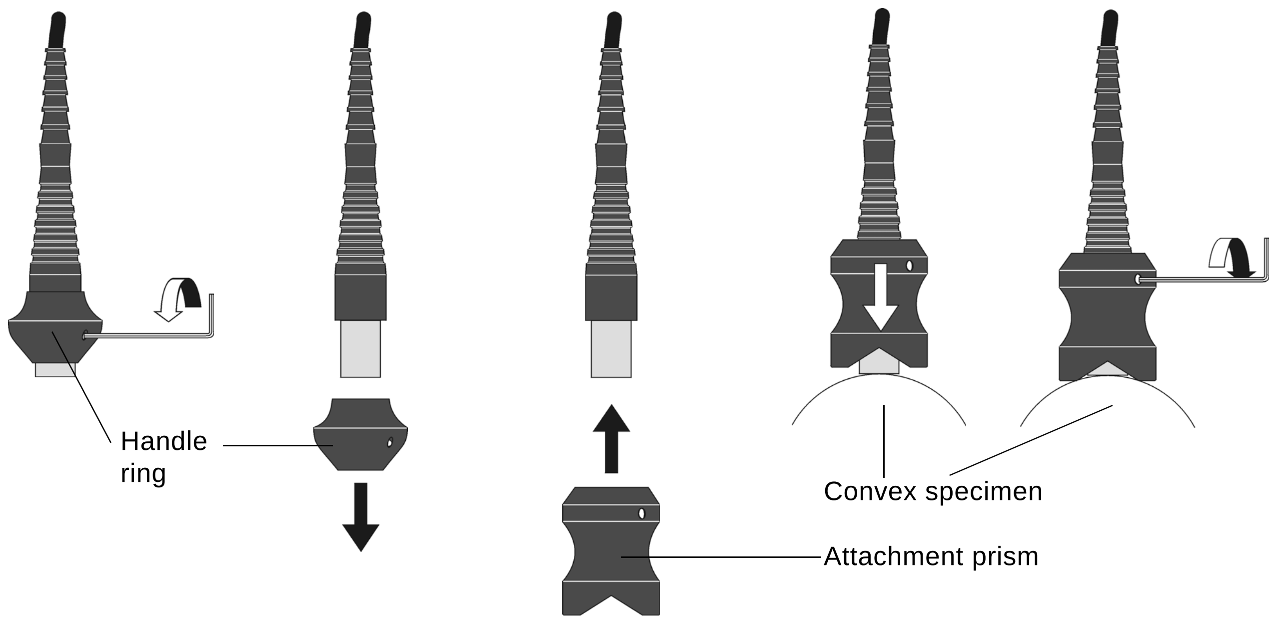
	SMP10-TF
Application	Measurements of temperatures on metal surfaces
Trueness	± 0.5 °C (°F) at +20 °C (68 °F) ambient temperature
Probe tip diameter	flat, 6 mm (0.24")
Sensor	Pt100, class B, tolerance according to DIN IEC 751
min. measurement area	6 mm (0.24")
Probe length	95 mm (3.74")

4.17.2 Replacing the Handle Ring/Attachment Prism

To facilitate the perpendicular placement of the probe on convex specimens, the handle ring can be replaced by an attachment prism.

Pull the handle ring off the probe.

Mount the attachment prism on the probe.



1. Use the Allen key (included with the attachment prism) to loosen the set screw.
2. Pull the handle ring off the probe.
3. Push the attach ment prism as far as possible onto the probe.
4. Place the probe and the attachment prism on the curved specimen surface and move the attachment prism towards the specimen.
5. Secure the attachment prism using the set screw.

4.17.3 Influence of the Material Thickness

Inadequate material thicknesses can significantly influence the measurement results. The minimum thickness depends on the material and the probe frequency and is a result of the penetration depth of the induced eddy currents in the material.

Generally, the following applies to the penetration depth δ of the eddy currents into a nonferrous metal:

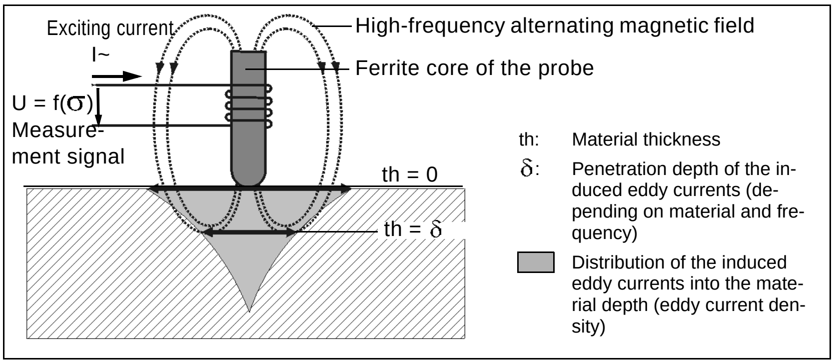
$$\delta = \delta_0 = \frac{503}{\sqrt{f \cdot \sigma}} \text{ mm}$$

δ: Penetration depth of the induced eddy currents [mm]

δ_0: Standard penetration depth of the induced eddy currents for a definite measurement frequency and a definite material.

f: Measurement frequency (= probe frequency) [kHz]

σ: Electrical conductivity [MS/m]



Principle of the penetration of the alternating magnetic field and the distribution of the induced eddy currents and their distribution into the depth in non-magnetizable metals.

You can calculate the minimum thickness using the following empirical equation:

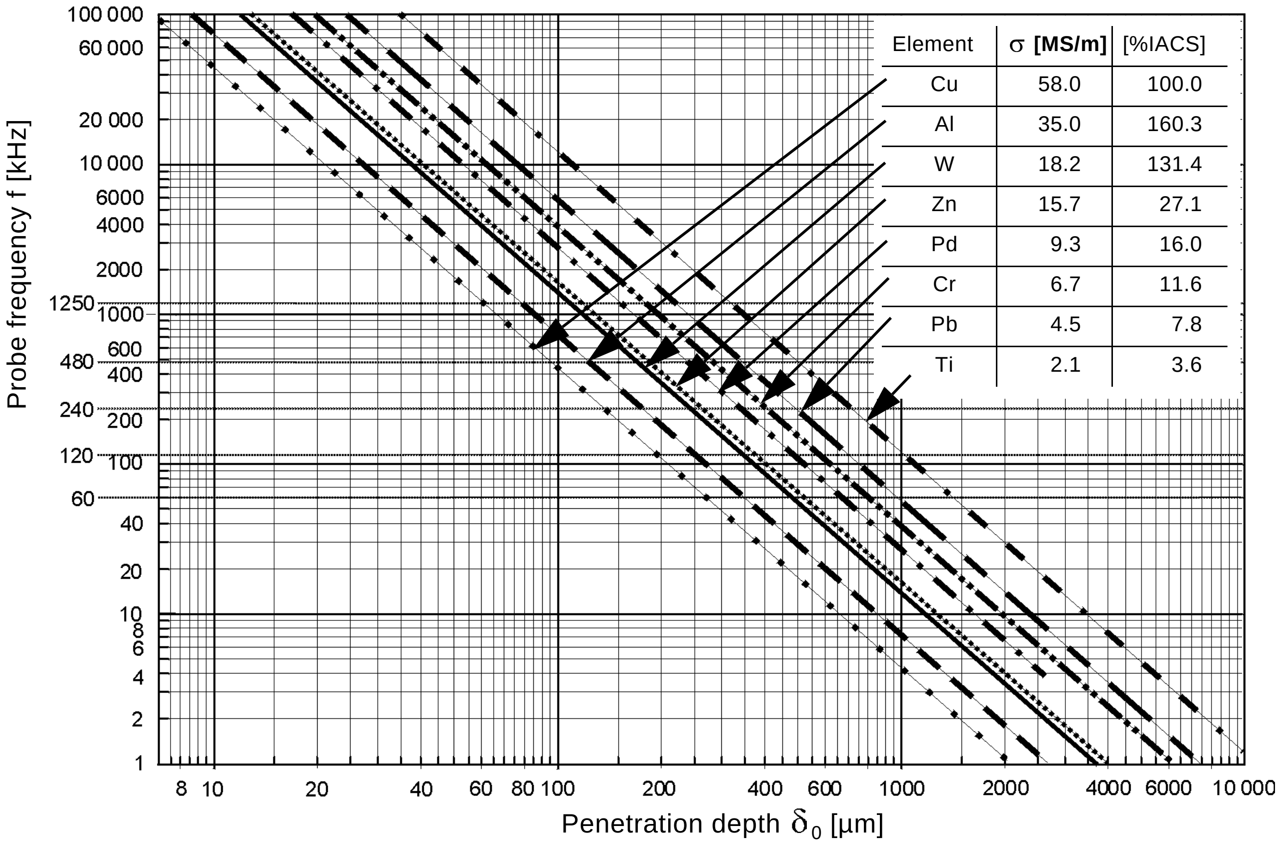
$$th_{min} \geq 3 \bullet \delta_0$$

th_{min} : Minimum material thickness that allows a conductivity measurement.

δ_0 : Standard penetration depth of the induced eddy currents (dpendent on the material and the probe frequency).

Corresponding to the probe frequency in use, Fig. A-1 on the following page shows the respective standard penetration depths δ_0 for various materials.

Example:
Fig. A-1 shows that for aluminum and a probe frequency of 60 kHz the resultant δ_0 is 350 µm. According to the equation above, the resultant minimum material thickness is 1.05 mm. A change in the probe frequency to 480 kHz leads to a δ_0 of 125 µm. This results in a minimum material thickness of 375 µm.



Element	σ [MS/m]	[%IACS]
Cu	58.0	100.0
Al	35.0	160.3
W	18.2	131.4
Zn	15.7	27.1
Pd	9.3	16.0
Cr	6.7	11.6
Pb	4.5	7.8
Ti	2.1	3.6

Fig. A-1: Penetration depth δ_0 of the induced eddy currents as a function of the frequency f for various materials and their electrical conductivities σ.

4.17.4 Influence of the Curvature on Cylindrical Specimens

In addition to the temperature, the curvature of the specimen influences the conductivity measurement. The influence on the conductivity measurement increases as the diameter of the curvature decreases. Fig. A-2 shows an example of the relative conductivity error in relation to the diameter of the curvature for 3 different materials (for the ES40 probe and a probe frequency of 60 kHz). Curvature diameters beginning at 4 mm can be taken into account using the curvature correction function (**File/Properties**, tab *Curvature correction*, 4-10).

The curvature correction is available only together with the ES40 probe!

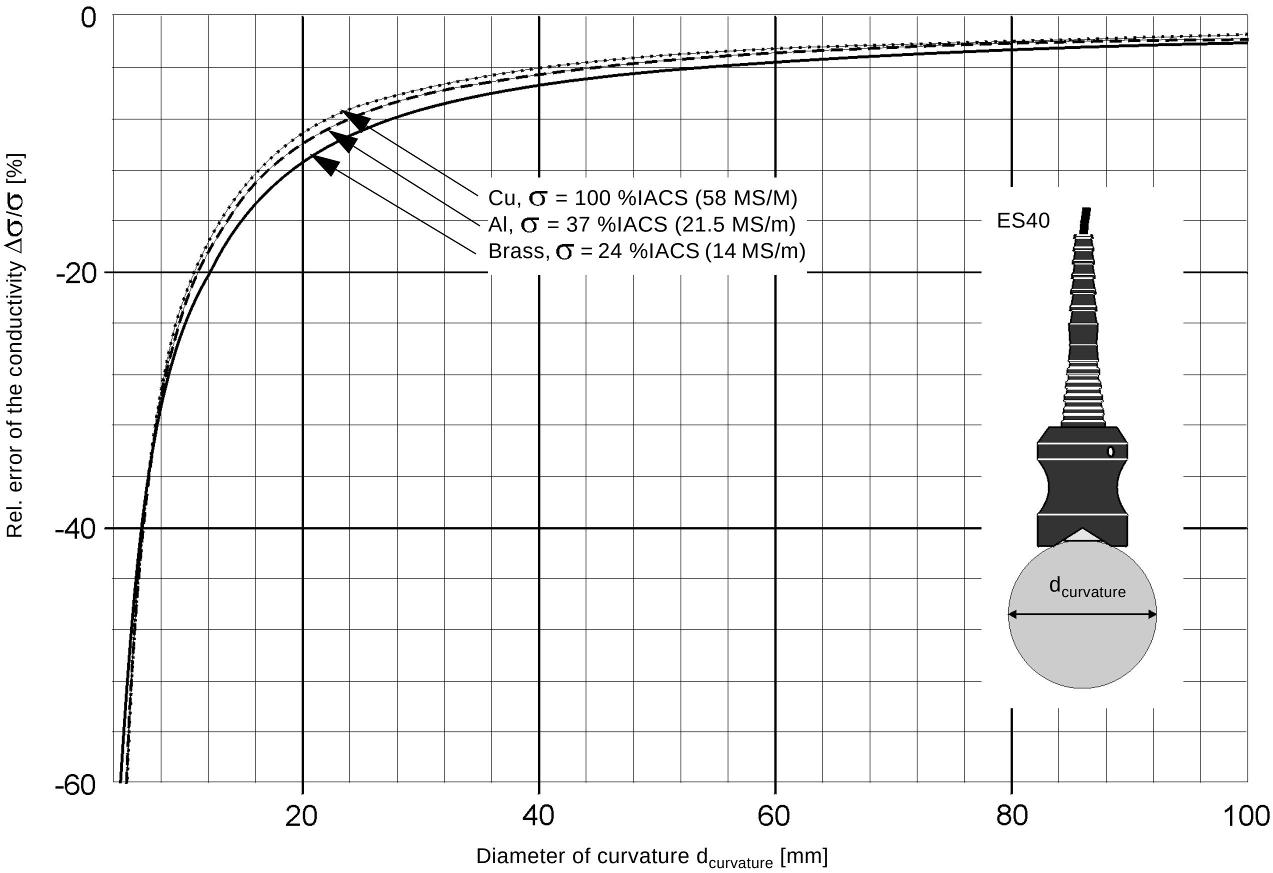


Fig. A-2:: Relative conductivity error $\Delta\sigma/\sigma$ as a function of the diameter of the curvature $d_{curvature}$ of the specimen for the ES40 probe at a probe frequency of 60 kHz.

4.17.5 Corrective Calibration (Instrument Adjust)

The corrective calibration not only makes adjustments to the zero point for the electr. conductivity reading 0 MS/m (0 %IACS) but also to at least one further value. The corrective calibration can be performed using up to 4 standards.

The corrective calibration applies only to the probe frequency set in the active application and for the conductivity range of the used standards/reference parts. Example: standards with 22 and 34 MS/m or 39 and 59 %IACS, respectively. This means, a correct measurement with the trueness specified in the technical data is possible only in the range from 22 to 34 MS/m. A new corrective calibration (possibly in a new and different application) must be performed for measurements outside of this range (e.g., at 10 MS/m or 17 %IACS, respectively).

Required:

- If the specified trueness cannot be met.
  This may be caused by age-related probe behavior changes. The behavior of electronic components can change over time. Such a so-called drift can be compensated for using a corrective calibration.
- If the curvature correction of the instrument is not used, for example because the measurements are made on a smaller curvature diameter or because the curvature correction function of the instrument does not support the connected probe (ES40HF, ES20, ES24). In such cases, the corrective calibration can be used to take the curvature of the specimen into account.

We recommend checking the calibration of instrument and probe in regular intervals through check measurements on reference pieces!

The influence of the temperature of electrical conductivity must be taken into account when making corrective calibrations. Either the temperature and the temperature coefficient or the material of the standard/reference piece must be known (corrective calibration with temperature compensation) or the standards/reference pieces must be at a temperature of +20 °C (+68 °F) (standards/reference pieces are, for example, placed in a temperature-controlled water bath - corrective calibration without temperature compensation).

The temperature is entered manually, confirmed or automatically continuously measured corresponding to the application settings (**File**/**Properties**, window *Properties*, tab *Temperature*).

The **corrective calibration** can also be performed **without temperature compensation**. In this case all measured conductivity readings referenced to +20 °C (+68 °F). Therefore pay attention to the specimen/standard temperature, it must be +20 °C (e.g., measure on standards/specimen in a water bath).

If measurements are made at +23 °C (+73.4 °F), for example, instead of at +20 °C (+68 °F) and if the nominal value (referenced to +20 °C (+68 °F)) noted on the standard is entered during the corrective calibration, then the subsequent readings on the specimen at +23 °C (+73.4 °F) will also be referenced to +20 °C (+68 °F). However, the readings will have an error corresponding to the difference of the temperature coefficients of both materials (standard, specimen).

The procedure for the corrective calibration with temperature compensation is described in section "Procedure". Tap the button **No Temp.** in step #4 to differ the described procedure to calibration without temperature compensation. Temperature and temperature coefficient are not used.

For **application set up with automatic temperature compensation** (application properties, 4-8) the corrective calibration will be performed necessary with temperature compensation (with autom. acception of the temperature from the temperature sensor and entry of the temperature coefficient α or selection of the specimen material).

If the **corrective calibration is carried out on curved reference pieces**, then the curvature correction function of the instrument must be disabled when making measurements on equally curved specimens!

The corrective calibration applies only to the active application or to the linked applications.

Required materials/standards:

- At least one standard/reference piece (max. 4) must be available for the corrective calibration. The values of the standards should be in the same range as the electrical conductivity to be measured.

Probes supplied by Fischer are pre-calibrated (master calibrated).
The shipment of the probe includes a certified electr. conductivity standard. Additional certified electr. conductivity standards can be obtained from Fischer.

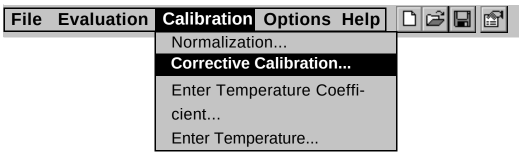
The procedure for the corrective calibration with temperature compensation is described below.

Perform the corrective calibration carefully! It determines the accuracy for the subsequent measurements. - Measurements can never be more accurate than the corrective calibration!

Procedure:

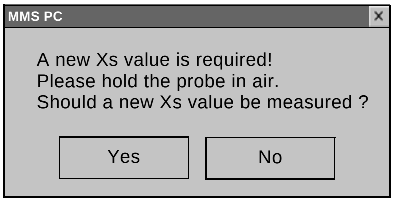
1. Calling the corrective calibration function:

1. Tap **Calibration / Corrective Calibration ...** on the display in succession using the stylus.



2. Get "air value":

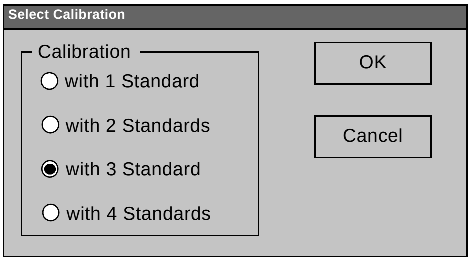
1. Hold probe in the air. The distance to the closest object must be a minimum of 5 cm (2").
2. Tap the **Yes** button with stylus.



3. Select the number of standards used for the corrective calibration:

1. Tap the desired number of standards with the stylus.
2. Tap the **OK** button with the stylus to confirm the selection.

The window *Correction Calibration* opens.



4. Capture temperature of the current standard:

- **Manual temperature entry**.

1. Enter the current temperature of the present standard into the field. Use the entry bar at the bottom of the program window, tap the numbers in succession

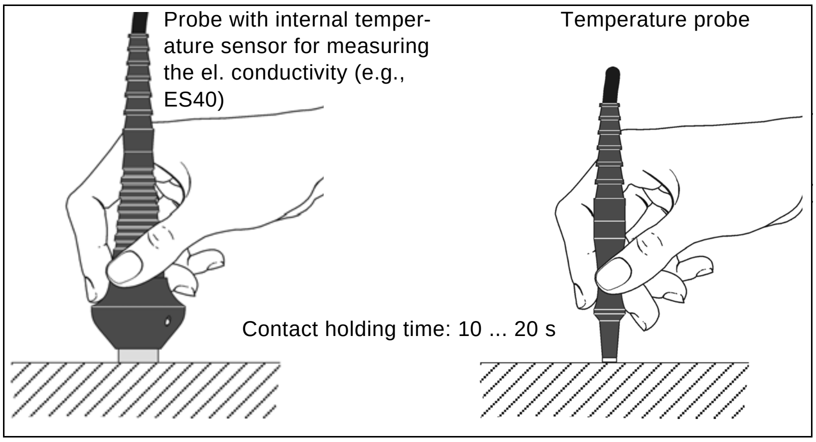
Window *Correction Calibration,* **tab** *Temperature*

For application set up: **File/ Properties**/tab *Temperature*, parameter: **Temperture correction with manual temperature input**.

- **Measure temperature with temperature sensor**

1. Hold it several seconds (10 to 20 seconds) the sensor to take the temperature of the standard properly.

2. Accept the sensor temperature: tap on button **<< Temperature** with the stylus.



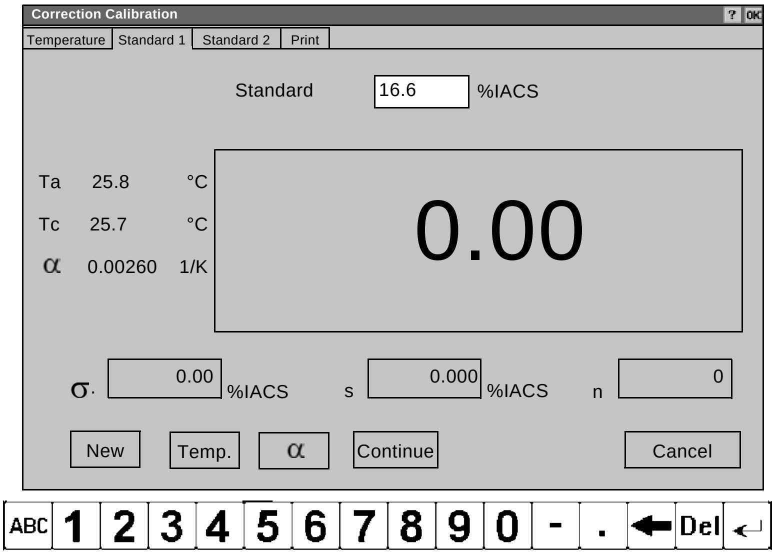
For application set up: **File/ Properties**/tab *Temperature*, parameter: **Temperature correction with external sensor** or parameter: **Temperature correction with sensor in probe**.

5. Tap "Continue" button with the stylus.

6. Characteristics for standard 1 (2, 3, 4):

Window *Correction Calibration*, **tab** *Standard1*

1. Check the displayed conductivity value (field Standard) with the value of the present standard - change entry: Double-tap on the entry field. Use the entry bar at the bottom of the program window, tap the numbers in succession (Example: 1 6 . 6 for the conductivity of 16.6 %IACS labeled on standard).



Parameter description

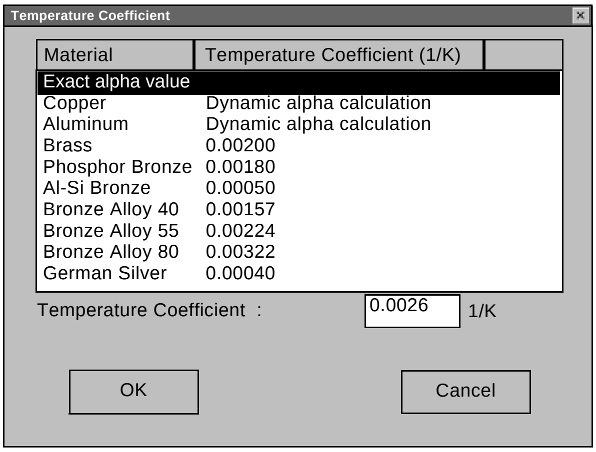
σ:	measured electrical conductivity reading
σ.:	mean value of the measured readings
n:	number of readings
s:	standard deviation
Tc:	temperature obtained from the temperature sensor = temperature of the standard
TA:	currently measured temperature of the temperature sensor (not used with manual temperature input)
α:	Material of the specimen or "exact alpha value" (temperature coefficient).

Pay attention to the unit!

2. Check temperature coefficient α of standard (1) - change entry: tap α button.
Enter the temperature coefficient α or select the material of the present standard from list.

For coefficient entry: Double-tap on the entry field. Use the entry bar at the bottom of the program window, tap the numbers in succession.

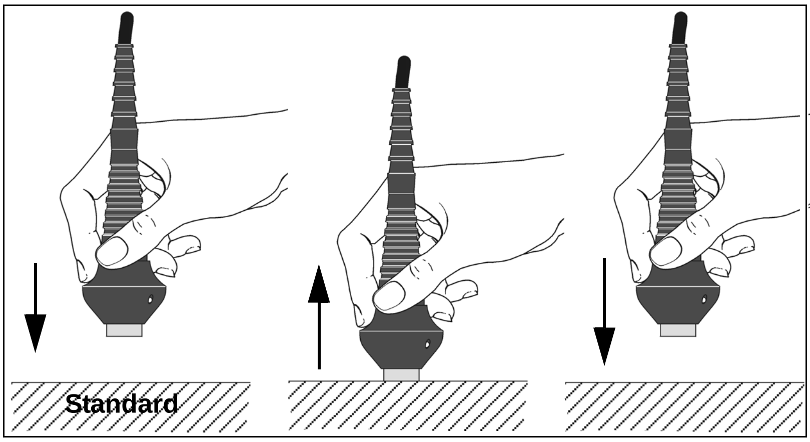
Tap the **OK** button with the stylus to confirm the entry.



7. Measure on standard:

1. Perform 5 to 10 measurements on the calibration standard (1, 2, 3, ...).

2. Tap the **Continue** button with the stylus. After measuring on the last standard tap the **Finish** button.



8. Measure on additional Standards

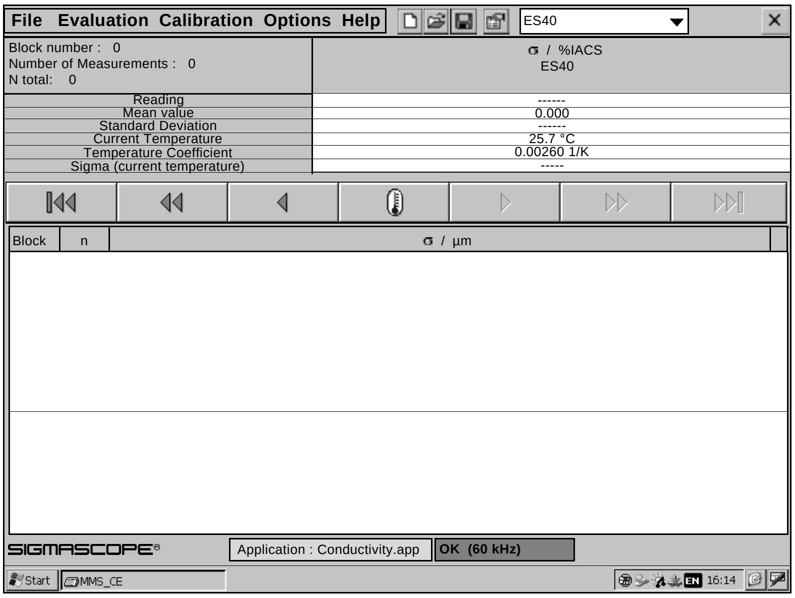
Depending on the selected numbers of standards in step #**3.** repeat steps #**6.** and #**7.** with the additional standards. After tapping the **Finish** button the window *Correction Calibration* closes. The **Finish** button appears only on the tab sheet of the last standard to be measured.

9. Saving the parameters of the corrective calibration in the current application:

3. Tap the button with the stylus.

The corrective calibration is finished and has been stored in the open application. Thus, for this application, a new corrective calibration is not required before every measurement.

Measurements can be perform in the current application.



Measuring mode Numeric Display. Example for an application set up wit probe ES40 for measurements with temperature compensation.

4.17.6 Correction Factors According to BOEING Specifications BAC 5651 and BSS 7351

In addition to the temperature, the curvature of the specimen, the thickness of the specimen (violation of the specified minimum material thickness) and a potential sheathing (e.g., aluminum foil used in the aeronautics industry) influence, or falsify, the measurement of the electr. conductivity. The tables listed in this chapter apply exclusively to the ES40 probe and are intended for a **manual correction** of the conductivity values after the measurement.

Shown in the tables are the true conductivity values of the specimen materials and the respective falsified measured values (displayed readings). Correction tables exist for every frequency of the ES40 probe (60, 120, 240 and 480 kHz).
The following tables have been set up and are to be used according to the BOEING specifications BAC 5651 and BSS 7351.

The correction values have been determined exclusively using original standards provided by BOEING according to the BOEING specification BAC 5651. The tables are to be used according to BOEING specification BSS 7351.

For using the tables, we recommend setting up an application with the temperature compensation enabled.
Setting up a new application, 🗐 4-2.
Enable temperature compensation, 🗐 4-8.
Selection of the specimen material (base material, alpha value), 🗐 4-11.

To use the following correction tables, the function "curvature correction" must be disabled for the open application.

If the use of the BOEING tables is not mandatory, we recommend enabling the curvature correction of the instrument for the measurement in addition to the temperature compensation. The curvature correction of the instrument provides a better accuracy and the correction covers the entire measuring range. 🗐 Enable the curvature correction, page 4-10.

BSS 7351, correction factors for convex curved specimens, measurements with a probe frequency of 60 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 60 kHz										
	Diameter of curvature in Inches *(cm)*										
	0.250 *0.63*	**0.375** *0.950*	**0.500** *1.27*	**0.750** *1.91*	**1.000** *2.54*	**1.500** *3.81*	**2.000** *5.08*	**3.000** *7.62*	**3.500** *8.89*	**4.000** *10.16*	**5.000** *12.70*
	Corrected conductivity values in %IACS										
20	11.5	14.0	16.5	18.0	18.5	19.0	19.0	19.5	19.5	19.5	19.5
21	12.5	15.0	17.5	19.0	19.5	20.0	20.0	20.5	20.5	20.5	20.5
22	13.0	15.5	18.0	19.5	20.5	21.0	21.0	21.5	21.5	21.5	21.5
23	13.5	16.5	19.0	20.5	21.5	22.0	22.0	22.0	22.5	22.5	22.5
24	14.0	17.0	20.0	21.5	22.0	23.0	23.0	23.0	23.5	23.5	23.5
25	15.0	18.0	20.5	22.5	23.0	24.0	24.0	24.0	24.0	24.5	24.5
26	15.5	18.5	21.5	23.5	24.0	25.0	25.0	25.0	25.0	25.5	25.5
27	16.0	19.0	22.5	24.0	25.0	25.5	26.0	26.0	26.0	26.5	26.5
28	16.5	20.0	23.0	25.0	26.0	26.5	27.0	27.0	27.0	27.5	27.5
29	17.5	20.5	24.0	26.0	27.0	27.5	27.5	28.0	28.0	28.0	28.5
30	18.0	21.5	25.0	27.0	28.0	28.5	28.5	29.0	29.0	29.0	29.5
31	18.5	22.0	25.5	28.0	28.5	29.5	29.5	30.0	30.0	30.0	30.5
32	19.5	23.0	26.5	28.5	29.5	30.5	30.5	31.0	31.0	31.0	31.5
33	20.0	23.5	27.5	29.5	30.5	31.5	31.5	32.0	32.0	32.0	32.5
34	20.5	24.5	28.0	30.5	31.5	32.0	32.5	32.5	33.0	33.0	33.5
35	21.0	25.0	29.0	31.5	32.5	33.0	33.5	33.5	34.0	34.0	34.5
36	22.0	26.0	30.0	32.0	33.5	34.0	34.5	34.5	35.0	35.0	35.5
37	22.5	26.5	30.5	33.0	34.5	35.0	35.0	35.5	36.0	36.0	36.5
38	23.0	27.5	31.5	34.0	35.0	36.0	36.0	36.5	37.0	37.0	37.5
39	23.5	28.0	32.5	35.0	36.0	37.0	37.0	37.5	37.5	38.0	38.5
40	24.5	28.5	33.0	36.0	37.0	38.0	38.0	38.5	38.5	39.0	39.5
41	25.0	29.5	34.0	36.5	38.0	39.0	39.0	39.5	39.5	40.0	40.5
42	25.5	30.0	35.0	37.5	39.0	39.5	40.0	40.5	40.5	41.0	41.5
43	26.0	31.0	35.5	38.5	40.0	40.5	41.0	41.5	41.5	42.0	42.5
44	27.0	31.5	36.5	39.5	41.0	41.5	42.0	42.5	42.5	43.0	43.5
45	27.5	32.5	37.5	40.5	41.5	42.5	43.0	43.5	43.5	44.0	44.5
46	28.0	33.0	38.0	41.0	42.5	43.5	43.5	44.0	44.5	44.5	45.5
47	28.5	34.0	39.0	42.0	43.5	44.5	44.5	45.0	45.5	45.5	46.0
48	29.5	34.5	39.5	43.0	44.5	45.5	45.5	46.0	46.5	46.5	47.0
49	30.0	35.5	40.5	44.0	45.5	46.5	46.5	47.0	47.5	47.5	48.0
50	30.5	36.0	41.5	45.0	46.5	47.0	47.5	48.0	48.5	48.5	49.0
51	31.0	37.0	42.0	45.5	47.5	48.0	48.5	49.0	49.5	49.5	50.0
52	32.0	37.5	43.0	46.5	48.0	49.0	49.5	50.0	50.5	50.5	51.0
53	32.5	38.0	44.0	47.5	49.0	50.0	50.5	51.0	51.0	51.5	52.0
54	33.0	39.0	44.5	48.5	50.0	51.0	51.5	52.0	52.0	52.5	53.0
55	34.0	39.5	45.5	49.0	51.0	52.0	52.0	53.0	53.0	53.5	54.0
56	34.5	40.5	46.5	50.0	52.0	53.0	53.0	54.0	54.0	54.5	55.0
57	35.0	41.0	47.0	51.0	53.0	53.5	54.0	55.0	55.0	55.5	56.0
58	35.5	42.0	48.0	52.0	54.0	54.5	55.0	55.5	56.0	56.5	57.0
59	36.5	42.5	49.0	53.0	54.5	55.5	56.0	56.5	57.0	57.5	58.0
60	37.0	43.5	49.5	53.5	55.5	56.5	57.0	57.5	58.0	58.5	59.0

BSS 7351, correction factors for convex curved specimens, measurements with a probe frequency of 120 kHz

Uncorrected conductivity values in % IACS	**Probe ES40, probe frequency 120 kHz**										
	Diameter of curvature in Inches *(cm)*										
	0.250 *0.63*	**0.375** *0.950*	**0.500** *1.27*	**0.750** *1.91*	**1.000** *2.54*	**1.500** *3.81*	**2.000** *5.08*	**3.000** *7.62*	**3.500** *8.89*	**4.000** *10.16*	**5.000** *12.70*
	Corrected conductivity values in %IACS										
20	12.0	14.5	16.5	18.0	18.5	19.5	19.5	19.5	19.5	19.5	19.5
21	13.0	15.0	17.5	19.0	19.5	20.5	20.5	20.5	20.5	20.5	20.5
22	13.5	16.0	18.5	20.0	20.5	21.5	21.5	21.5	21.5	21.5	21.5
23	14.0	16.5	19.0	21.0	21.5	22.5	22.5	22.5	22.5	22.5	22.5
24	15.0	17.5	20.0	21.5	22.5	23.0	23.5	23.5	23.5	23.5	23.5
25	15.5	18.0	21.0	22.5	23.5	24.0	24.0	24.5	24.5	24.5	24.5
26	16.0	19.0	21.5	23.5	24.5	25.0	25.0	25.5	25.5	25.5	25.5
27	16.5	19.5	22.5	24.5	25.0	26.0	26.0	26.0	26.5	26.5	26.5
28	17.5	20.5	23.5	25.0	26.0	27.0	27.0	27.0	27.5	27.5	27.5
29	18.0	21.0	24.0	26.0	27.0	28.0	28.0	28.0	28.0	28.5	28.5
30	18.5	22.0	25.0	27.0	28.0	28.5	29.0	29.0	29.0	29.5	29.5
31	19.5	22.5	26.0	28.0	29.0	29.5	30.0	30.0	30.0	30.5	30.5
32	20.0	23.5	26.5	29.0	30.0	30.5	30.5	31.0	31.0	31.0	31.5
33	20.5	24.0	27.5	29.5	30.5	31.5	31.5	32.0	32.0	32.0	32.5
34	21.5	25.0	28.5	30.5	31.5	32.5	32.5	33.0	33.0	33.0	33.5
35	22.0	25.5	29.0	31.5	32.5	33.5	33.5	34.0	34.0	34.0	34.5
36	22.5	26.5	30.0	32.5	33.5	34.5	34.5	35.0	35.0	35.0	35.5
37	23.0	27.0	31.0	33.5	34.5	35.0	35.5	35.5	36.0	36.0	36.5
38	24.0	28.0	32.0	34.0	35.5	36.0	36.5	36.5	37.0	37.0	37.5
39	24.5	28.5	32.5	35.0	36.0	37.0	37.0	37.5	38.0	38.0	38.5
40	25.0	29.5	33.5	36.0	37.0	38.0	38.0	38.5	39.0	39.0	39.5
41	26.0	30.0	34.5	37.0	38.0	39.0	39.0	39.5	39.5	40.0	40.5
42	26.5	31.0	35.0	38.0	39.0	40.0	40.0	40.5	40.5	41.0	41.5
43	27.0	31.5	36.0	38.5	40.0	40.5	41.0	41.5	41.5	42.0	42.5
44	28.0	32.5	37.0	39.5	41.0	41.5	42.0	42.5	42.5	43.0	43.5
45	28.5	33.0	37.5	40.5	41.5	42.5	43.0	43.5	43.5	44.0	44.5
46	29.0	34.0	38.5	41.5	42.5	43.5	43.5	44.0	44.5	44.5	45.5
47	29.5	34.5	39.5	42.0	43.5	44.5	44.5	45.0	45.5	45.5	46.0
48	30.5	35.5	40.0	43.0	44.5	45.5	45.5	46.0	46.5	46.5	47.0
49	31.0	36.0	41.0	44.0	45.5	46.0	46.5	47.0	47.5	47.5	48.0
50	31.5	36.5	42.0	45.0	46.5	47.0	47.5	48.0	48.5	48.5	49.0
51	32.5	37.5	42.5	46.0	47.0	48.0	48.5	49.0	49.5	49.5	50.0
52	33.0	38.0	43.5	46.5	48.0	49.0	49.5	50.0	50.0	50.5	51.0
53	33.5	39.0	44.5	47.5	49.0	50.0	50.0	51.0	51.0	51.5	52.0
54	34.5	39.5	45.0	48.5	50.0	51.0	51.0	52.0	52.0	52.5	53.0
55	35.0	40.5	46.0	49.5	51.0	51.5	52.0	52.5	53.0	53.5	54.0
56	35.5	41.0	47.0	50.5	52.0	52.5	53.0	53.5	54.0	54.5	55.0
57	36.0	42.0	47.5	51.0	53.0	53.5	54.0	54.5	55.0	55.5	56.0
58	37.0	42.5	48.5	52.0	53.5	54.5	55.0	55.5	56.0	56.5	57.0
59	37.5	43.5	49.5	53.0	54.5	55.5	56.0	56.5	57.0	57.5	58.0
60	38.0	44.0	50.0	54.0	55.5	56.5	56.5	57.5	58.0	58.0	59.0

BSS 7351, correction factors for convex curved specimens, measurements with a probe frequency of 240 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 240 kHz										
	Diameter of curvature in Inches *(cm)*										
	0.250 *0.63*	**0.375** *0.950*	**0.500** *1.27*	**0.750** *1.91*	**1.000** *2.54*	**1.500** *3.81*	**2.000** *5.08*	**3.000** *7.62*	**3.500** *8.89*	**4.000** *10.16*	**5.000** *12.70*
	Corrected conductivity values in %IACS										
20	12.5	14.5	16.5	18.0	18.5	20.0	20.0	20.0	20.0	20.0	20.0
21	13.0	15.5	17.5	19.0	19.5	21.0	21.0	21.0	21.0	21.0	21.0
22	14.0	16.0	18.5	20.0	20.5	22.0	22.0	22.0	22.0	22.0	22.0
23	14.5	17.0	19.0	21.0	21.5	22.5	22.5	22.5	22.5	22.5	23.0
24	15.0	17.5	20.0	21.5	22.0	23.5	23.5	23.5	23.5	23.5	23.5
25	16.0	18.5	21.0	22.5	23.0	24.5	24.5	24.5	24.5	24.5	24.5
26	16,5	19,0	22,0	23,5	24,0	25,5	25,5	25,5	25,5	25,5	25,5
27	17,0	20,0	22,5	24,5	25,0	26,5	26,5	26,5	26,5	26,5	26,5
28	18.0	20.5	23.5	25.5	26.0	27.0	27.5	27.5	27.5	27.5	27.5
29	18.5	21.5	24.5	26.0	27.0	28.0	28.0	28.5	28.5	28.5	28.5
30	19.0	22.0	25.0	27.0	28.0	29.0	29.0	29.5	29.5	29.5	29.5
31	20.0	23.0	26.0	28.0	28.5	30.0	30.0	30.0	30.5	30.5	30.5
32	20.5	23.5	27.0	29.0	29.5	31.0	31.0	31.0	31.5	31.5	31.5
33	21.0	24.5	27.5	29.5	30.5	31.5	32.0	32.0	32.0	32.5	32.5
34	21.5	25.0	28.5	30.5	31.5	32.5	33.0	33.0	33.0	33.5	33.5
35	22.5	26.0	29.5	31.5	32.5	33.5	33.5	34.0	34.0	34.0	34.5
36	23.0	26.5	30.0	32.5	33.5	34.5	34.5	35.0	35.0	35.0	35.5
37	23.5	27.5	31.0	33.5	34.5	35.5	35.5	36.0	36.0	36.0	36.5
38	24.5	28.0	32.0	34.0	35.5	36.5	36.5	37.0	37.0	37.0	37.5
39	25.0	29.0	32.5	35.0	36.0	37.0	37.5	37.5	38.0	38.0	38.5
40	25.5	29.5	33.5	36.0	37.0	38.0	38.5	38.5	39.0	39.0	39.5
41	26.5	30.5	34.5	37.0	38.0	39.0	39.0	39.5	40.0	40.0	40.5
42	27.0	31.0	35.0	38.0	39.0	40.0	40.0	40.5	40.5	41.0	41.5
43	27.5	32.0	36.0	38.5	40.0	41.0	41.0	41.5	41.5	42.0	42.5
44	28.5	32.5	37.0	39.5	41.0	41.5	42.0	42.5	42.5	43.0	43.5
45	29.0	33.5	38.0	40.5	42.0	42.5	43.0	43.5	43.5	44.0	44.5
46	29.5	34.0	38.5	41.5	43.0	43.5	44.0	44.5	44.5	45.0	45.5
47	30.5	35.0	39.5	42.0	43.5	44.5	44.5	45.0	45.5	45.5	46.5
48	31.0	35.5	40.5	43.0	44.5	45.5	45.5	46.0	46.5	46.5	47.0
49	31.5	36.5	41.0	44.0	45.5	46.5	46.5	47.0	47.5	47.5	48.0
50	32.0	37.0	42.0	45.0	46.5	47.0	47.5	48.0	48.5	48.5	49.0
51	33.0	38.0	43.0	46.0	47.5	48.0	48.5	49.0	49.5	49.5	50.0
52	33.5	38.5	43.5	46.5	48.5	49.0	49.5	50.0	50.0	50.5	51.0
53	34.0	39.5	44.5	47.5	49.5	50.0	50.0	51.0	51.0	51.5	52.0
54	35.0	40.0	45.5	48.5	50.0	51.0	51.0	52.0	52.0	52.5	53.0
55	35.5	41.0	46.0	49.5	51.0	51.5	52.0	52.5	53.0	53.5	54.0
56	36.0	41.5	47.0	50.5	52.0	52.5	53.0	53.5	54.0	54.5	55.0
57	37.0	42.5	48.0	51.0	53.0	53.5	54.0	54.5	55.0	55.5	56.0
58	37.5	43.0	48.5	52.0	54.0	54.5	55.0	55.5	56.0	56.5	57.0
59	38.0	44.0	49.5	53.0	55.0	55.5	55.5	56.5	57.0	57.0	58.0
60	39.0	44.5	50.5	54.0	56.0	56.0	56.5	57.5	58.0	58.0	59.0

BSS 7351, correction factors for convex curved specimens, measurements with a probe frequency of 480 kHz

Uncorrected conductivity values in % IACS	**Probe ES40, probe frequency 480 kHz**										
	Diameter of curvature in Inches *(cm)*										
	0.250 *0.63*	**0.375** *0.950*	**0.500** *1.27*	**0.750** *1.91*	**1.000** *2.54*	**1.500** *3.81*	**2.000** *5.08*	**3.000** *7.62*	**3.500** *8.89*	**4.000** *10.16*	**5.000** *12.70*
	Corrected conductivity values in %IACS										
20	13.0	15.0	17.0	18.0	18.5	19.5	19.5	19.5	19.5	19.5	19.5
21	13.5	15.5	18.0	19.0	19.5	20.5	20.5	20.5	20.5	20.5	20.5
22	14.0	16.5	18.5	20.0	20.5	21.0	21.5	21.5	21.5	21.5	21.5
23	15.0	17.0	19.5	21.0	21.5	22.0	22.0	22.5	22.5	22.5	22.5
24	15.5	18.0	20.5	21.5	22.5	23.0	23.0	23.5	23.5	23.5	23.5
25	16.0	18.5	21.0	22.5	23.0	24.0	24.0	24.5	24.5	24.5	24.5
26	16.5	19.5	22.0	23.5	24.0	25.0	25.0	25.0	25.5	25.5	25.5
27	17.5	20.0	23.0	24.5	25.0	26.0	26.0	26.0	26.5	26.5	26.5
28	18.0	21.0	23.5	25.0	26.0	27.0	27.0	27.0	27.0	27.5	27.5
29	18.5	21.5	24.5	26.0	27.0	27.5	28.0	28.0	28.0	28.5	28.5
30	19.0	22.5	25.5	27.0	28.0	28.5	29.0	29.0	29.0	29.5	29.5
31	20.0	23.0	26.0	28.0	29.0	29.5	29.5	30.0	30.0	30.5	30.5
32	20.5	23.5	27.0	29.0	29.5	30.5	30.5	31.0	31.0	31.0	31.5
33	21.0	24.5	27.5	29.5	30.5	31.5	31.5	32.0	32.0	32.0	32.5
34	22.0	25.0	28.5	30.5	31.5	32.5	32.5	33.0	33.0	33.0	33.5
35	22.5	26.0	29.5	31.5	32.5	33.5	33.5	34.0	34.0	34.0	34.5
36	23.0	26.5	30.0	32.5	33.5	34.5	34.5	35.0	35.0	35.0	35.5
37	23.5	27.5	31.0	33.0	34.5	35.0	35.5	35.5	36.0	36.0	36.5
38	24.5	28.0	32.0	34.0	35.5	36.0	36.5	36.5	37.0	37.0	37.5
39	25.0	29.0	32.5	35.0	36.0	37.0	37.0	37.5	38.0	38.0	38.5
40	25.5	29.5	33.5	36.0	37.0	38.0	38.0	38.5	39.0	39.0	39.5
41	26.0	30.5	34.5	37.0	38.0	39.0	39.0	39.5	39.5	40.0	40.5
42	27.0	31.0	35.0	37.5	39.0	40.0	40.0	40.5	40.5	41.0	41.5
43	27.5	32.0	36.0	38.5	40.0	41.0	41.0	41.5	41.5	42.0	42.5
44	28.0	32.5	37.0	39.5	41.0	41.5	42.0	42.5	42.5	43.0	43.5
45	29.0	33.0	37.5	40.5	42.0	42.5	43.0	43.5	43.5	44.0	44.5
46	29.5	34.0	38.5	41.0	42.5	43.5	44.0	44.5	44.5	45.0	45.5
47	30.0	34.5	39.5	42.0	43.5	44.5	44.5	45.5	45.5	46.0	46.5
48	30.5	35.5	40.0	43.0	44.5	45.5	45.5	46.0	46.5	46.5	47.5
49	31.5	36.0	41.0	44.0	45.5	46.5	46.5	47.0	47.5	47.5	48.0
50	32.0	37.0	42.0	45.0	46.5	47.5	47.5	48.0	48.5	48.5	49.0
51	32.5	37.5	42.5	45.5	47.5	48.0	48.5	49.0	49.5	49.5	50.0
52	33.0	38.5	43.5	46.5	48.0	49.0	49.5	50.0	50.5	50.5	51.0
53	34.0	39.0	44.5	47.5	49.0	50.0	50.5	51.0	51.5	51.5	52.0
54	34.5	40.0	45.0	48.5	50.0	51.0	51.5	52.0	52.0	52.5	53.0
55	35.0	40.5	46.0	49.0	51.0	52.0	52.5	53.0	53.0	53.5	54.0
56	35.5	41.5	46.5	50.0	52.0	53.0	53.0	54.0	54.0	54.5	55.0
57	36.5	42.0	47.5	51.0	53.0	54.0	54.0	55.0	55.0	55.5	56.0
58	37.0	42.5	48.5	52.0	54.0	54.5	55.0	55.5	56.0	56.5	57.0
59	37.5	43.5	49.0	53.0	54.5	55.5	56.0	56.5	57.0	57.5	58.0
60	38.5	44.0	50.0	53.5	55.5	56.5	57.0	57.5	58.0	58.5	59.0

BSS 7351, correction factors for measurements on thin, bare gauge with a probe frequency of 60 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 60 kHz						
	Single thickness (gauge) in Inches *(mm)*						
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.270*	**≥ 0.063** *≥ 1.600*
	Corrected conductivity values in % IACS						
26	13.5	19.0	23.5	27.5	27.5	26.5	26.0
27	14.0	20.0	25.0	28.5	29.0	27.5	27.0
28	14.5	21.0	26.5	29.5	30.0	28.5	28.0
29	15.5	22.5	28.0	31.0	31.0	29.5	29.0
30	16.0	24.0	29.0	32.0	32.0	30.5	30.0
31	19.0	25.5	30.5	33.0	33.0	31.5	31.0
32	20.5	27.0	32.0	34.5	33.5	32.5	32.0
33	21.0	28.0	33.0	35.5	34.5	33.5	33.0
34	22.0	29.5	34.0	36.5	35.5	34.5	34.0
35	22.5	30.5	35.5	37.5	36.5	35.5	35.0
36	23.0	32.0	36.5	38.5	37.5	36.5	36.0
37	24.0	33.0	38.0	40.0	38.5	37.5	37.0
38	24.5	34.5	39.0	41.0	39.5	38.5	38.0
39	25.0	35.5	40.5	42.0	40.0	39.0	39.0
40	26.0	37.0	41.5	43.0	41.0	40.0	40.0
41	27.5	38.0	43.0	44.5	42.0	41.0	41.0
42	30.0	38.5	44.5	45.5	43.5	42.0	42.0
43	32.5	39.0	46.0	46.5	44.5	43.0	43.0
44	35.0	40.0	47.5	47.5	45.5	44.0	44.0
45	37.0	40.5	49.0	49.0	46.5	45.0	45.0
46	38.0	42.0	50.0	49.5	47.5	46.0	46.0
47	39.0	43.5	51.0	50.5	48.5	47.0	47.0
48	40.0	45.5	52.5	51.5	49.0	48.0	48.0
49	40.5	47.0	53.5	52.5	50.0	49.0	49.0
50	41.5	48.5	54.5	53.5	51.0	50.0	50.0
51	42.0	50.0	56.0	54.0	52.0	51.0	51.0
52	43.0	52.0	57.0	55.0	53.0	52.0	52.0
53	44.0	53.5	58.0	56.0	53.5	53.0	53.0
54	44.5	55.0	59.0	57.0	54.5	54.0	54.0
55	45.5	56.5	60.5	58.0	55.5	55.0	55.0
56	46.5	58.0	61.5	58.5	56.5	56.0	56.0
57	47.0	60.0	62.5	59.5	57.5	57.0	57.0
58	48.0	61.5	64.0	60.5	58.0	58.0	58.0
59	49.0	63.0	65.0	61.5	59.0	59.0	59.0
60	50.0	64.5	66.0	62.5	60.0	60.0	60.0
61	51.5	65.5	67.0	63.5	61.0	61.0	61.0
62	53.0	66.5	67.5	64.0	62.0	62.0	62.0
63	54.5	67.5	68.5	65.0	63.0	63.0	63.0
64	56.0	68.5	69.5	66.0	64.0	64.0	64.0
65	57.5	69.5	70.5	67.0	65.0	65.0	65.0

BSS 7351, correction factors for measurements on 2014 or 2219 Clad Aluminum with a probe frequency of 60 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 60 kHz													
	Single thickness (gauge) in Inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.270*	**0.063** *1.600*	**0.080** *2.032*	**0.090** *2.286*	**0.100** *2.540*	**0.110** *2.794*	**0.125** *3.175*	**0.140** *3.556*	**0.160** *4.064*
	Corrected conductivity values in % IACS													
26	18.0	25.0	28.5	30.5	29.0	28.5	29.0	30.5	31.5	28.5	28.5	29.5	30.0	30.5
27	18.5	25.5	29.5	31.5	30.0	29.5	30.0	31.5	32.0	29.5	29.5	30.0	30.5	31.5
28	20.0	26.5	30.5	32.5	31.0	30.5	31.0	32.5	33.0	30.0	30.5	31.0	31.5	32.5
29	22.0	27.0	32.0	33.5	32.0	31.5	32.0	33.0	34.0	31.0	31.5	32.0	32.5	33.0
30	23.5	28.0	33.0	34.5	32.5	32.0	33.0	34.0	34.5	32.0	32.5	33.0	33.5	34.0
31	24.0	30.5	34.0	35.5	33.5	33.0	34.0	35.0	35.5	33.0	33.0	33.5	34.0	35.0
32	25.0	32.0	35.5	36.5	34.5	34.0	34.5	35.5	36.5	33.5	34.0	34.5	35.0	35.5
33	26.0	33.0	36.5	37.5	35.5	35.0	35.5	36.5	37.0	34.5	35.0	35.5	36.0	36.5
34	27.0	33.5	37.5	38.5	36.5	36.0	36.5	37.5	38.0	35.5	36.0	36.5	37.0	37.5
35	28.0	34.5	38.5	39.5	37.5	36.5	37.5	38.0	39.0	36.5	36.5	37.0	37.5	38.0
36	29.0	35.0	39.5	40.5	38.0	37.5	38.5	39.0	39.5	37.5	37.5	38.0	38.5	39.0
37	29.5	36.0	40.5	41.5	39.0	38.5	39.0	40.0	40.5	38.5	38.5	39.0	39.5	40.0
38	30.5	36.5	42.0	42.5	40.0	39.5	40.0	41.0	41.5	39.0	39.5	40.0	40.5	41.0
39	31.5	37.5	43.0	43.5	41.0	40.5	41.0	41.5	42.0	40.0	40.5	41.0	41.0	41.5
40	32.5	38.0	44.0	44.0	42.0	41.0	42.0	42.5	43.0	41.0	41.5	41.5	42.0	42.5
41	34.5	39.5	45.0	45.0	42.5	42.0	42.5	43.5	44.0	42.0	42.0	42.5	43.0	43.5
42	37.0	41.5	46.5	46.0	43.5	43.0	43.5	44.0	44.5	43.0	43.0	43.5	43.5	44.0
43	39.5	43.5	47.5	47.0	44.5	44.0	44.5	45.0	45.5	43.5	44.0	44.0	44.5	45.0
44	42.0	45.0	48.5	48.0	45.5	44.5	45.0	45.5	46.0	44.5	45.0	45.0	45.5	45.5
45	44.0	47.0	50.0	49.0	46.5	45.5	46.0	46.5	46.5	45.5	45.5	46.0	46.0	46.5
46	45.0	48.0	51.0	49.5	47.5	46.5	47.0	47.0	47.5	46.5	46.5	46.5	47.0	47.0
47	45.5	48.5	52.0	50.5	48.0	47.5	47.5	48.0	48.5	47.0	47.5	47.5	48.0	48.0
48	46.0	49.5	53.0	51.5	49.0	48.0	48.5	49.0	49.0	48.0	48.0	48.5	48.5	49.0
49	47.0	50.0	54.0	52.0	50.0	49.0	49.5	49.5	50.0	49.0	49.0	49.5	49.5	49.5
50	47.5	51.0	55.0	53.0	50.5	50.0	50.0	50.5	50.5	50.0	50.0	50.0	50.0	50.5
51	48.0	51.5	56.0	54.0	51.5	51.0	51.0	51.0	51.5	51.0	51.0	51.0	51.0	51.0

BSS 7351, correction factors for measurements on 2024, 7075, 7079 or 7178 Clad Aluminum with a probe frequency of 60 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 60 kHz													
	Single thickness (gauge) in Inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.270*	**0.063** *1.600*	**0.080** *2.032*	**0.090** *2.286*	**0.100** *2.540*	**0.110** *2.794*	**0.125** *3.175*	**0.140** *3.556*	**0.160** *4.064*
	Corrected conductivity values in % IACS													
26	15.5	20.0	26.0	29.0	29.0	28.5	27.0	27.5	28.0	28.5	28.5	29.5	30.0	30.5
27	16.0	21.0	27.5	30.5	30.0	29.5	28.0	28.5	29.0	29.5	29.5	30.0	30.5	31.5
28	17.0	22.5	28.5	31.5	31.0	30.5	29.0	29.5	30.0	30.0	30.5	31.0	31.5	32.5
29	18.0	23.5	30.0	32.5	32.0	31.5	29.5	30.5	31.0	31.0	31.5	32.0	32.5	33.0
30	18.5	25.0	31.5	33.5	32.5	32.0	30.5	31.5	31.5	32.0	32.5	33.0	33.5	34.0
31	20.5	26.5	32.5	34.5	33.5	33.0	31.5	32.0	32.5	33.0	33.0	33.5	34.0	35.0
32	21.5	28.0	33.5	35.5	34.5	34.0	32.5	33.0	33.5	33.5	34.0	34.5	35.0	35.5
33	22.5	29.0	34.5	36.5	35.5	35.0	33.5	34.0	34.5	34.5	35.0	35.5	36.0	36.5
34	23.0	30.5	36.0	37.5	36.5	36.0	34.5	35.0	35.0	35.5	36.0	36.5	37.0	37.5
35	24.0	31.5	37.0	38.5	37.5	36.5	35.5	36.0	36.0	36.5	36.5	37.0	37.5	38.0
36	24.5	32.5	38.0	39.5	38.0	37.5	36.5	37.0	37.0	37.5	37.5	38.0	38.5	39.0
37	25.5	34.0	39.5	40.5	39.0	38.5	37.5	37.5	38.0	38.5	38.5	39.0	39.5	40.0
38	26.5	35.0	40.5	41.5	40.0	39.5	38.5	38.5	39.0	39.0	39.5	40.0	40.5	41.0
39	27.0	36.0	42.0	42.5	41.0	40.5	39.5	39.5	40.0	40.0	40.5	41.0	41.0	41.5
40	28.0	37.5	43.0	43.5	42.0	41.0	40.5	40.5	41.0	41.0	41.5	41.5	42.0	42.5
41	30.0	38.5	44.0	44.5	42.5	42.0	41.0	41.5	41.5	42.0	42.0	42.5	43.0	43.5
42	32.5	39.5	45.5	45.5	43.5	43.0	42.0	42.5	42.5	43.0	43.0	43.5	43.5	44.0
43	35.0	40.5	46.5	46.5	44.5	44.0	43.0	43.5	43.5	43.5	44.0	44.0	44.5	45.0
44	37.5	42.0	48.0	47.5	45.5	44.5	44.0	44.5	44.5	44.5	45.0	45.0	45.5	45.5
45	40.0	43.0	49.0	48.5	46.5	45.5	45.0	45.0	45.5	45.5	45.5	46.0	46.0	46.5
46	41.0	44.0	50.5	49.5	47.5	46.5	46.0	46.0	46.0	46.5	46.5	46.5	47.0	47.0
47	41.5	45.0	51.5	50.5	48.0	47.5	47.0	47.0	47.0	47.0	47.5	47.5	48.0	48.0
48	42.0	46.0	52.5	51.5	49.0	48.0	47.5	48.0	48.0	48.0	48.0	48.5	48.5	49.0
49	43.0	47.0	53.5	52.0	50.0	49.0	48.5	49.0	49.0	49.0	49.0	49.5	49.5	49.5
50	43.5	47.5	54.5	53.0	50.5	50.0	49.5	49.5	50.0	50.0	50.0	50.0	50.0	50.5

BSS 7351, correction factors for measurements on 3003 or 6061 Clad Aluminum with a probe frequency of 60 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 60 kHz													
	Single thickness (gauge) in Inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.270*	**0.063** *1.600*	**0.080** *2.032*	**0.090** *2.286*	**0.100** *2.540*	**0.110** *2.794*	**0.125** *3.175*	**0.140** *3.556*	**0.160** *4.064*
	Corrected conductivity value in % IACS													
36	24.5	32.5	38.0	39.5	38.0	37.5	38.5	39.0	39.5	40.0	41.0	41.5	42.5	43.5
37	25.5	34.0	39.5	40.5	39.0	38.5	39.0	40.0	40.5	41.0	41.5	42.5	43.5	44.5
38	26.5	35.0	40.5	41.5	40.0	39.5	40.0	41.0	41.5	42.0	42.5	43.0	44.0	45.0
39	27.0	36.0	42.0	42.5	41.0	40.5	41.0	41.5	42.0	42.5	43.0	44.0	45.0	46.0
40	28.0	37.5	43.0	43.5	42.0	41.0	42.0	42.5	43.0	43.5	44.0	45.0	45.5	46.5
41	30.0	38.5	44.0	44.5	42.5	42.0	42.5	43.5	44.0	44.5	44.5	45.5	46.0	47.0
42	32.5	39.5	45.5	45.5	43.5	43.0	43.5	44.0	44.5	45.0	45.5	46.0	46.5	47.5
43	35.0	40.5	46.5	46.5	44.5	44.0	44.5	45.0	45.5	45.5	46.0	46.5	47.0	48.0
44	37.5	42.0	48.0	47.5	45.5	44.5	45.0	45.5	46.0	46.5	46.5	47.0	47.5	48.5
45	40.0	43.0	49.0	48.5	46.5	45.5	46.0	46.5	46.5	47.0	47.5	48.0	48.5	49.0
46	41.0	44.0	50.5	49.5	47.5	46.5	47.0	47.0	47.5	48.0	48.0	48.5	49.0	49.5
47	41.5	45.0	51.5	50.5	48.0	47.5	47.5	48.0	48.5	48.5	49.0	49.0	49.5	50.0
48	42.0	46.0	52.5	51.5	49.0	48.0	48.5	49.0	49.0	49.5	49.5	50.0	50.0	50.5
49	43.0	47.0	53.5	52.0	50.0	49.0	49.5	49.5	50.0	50.0	50.0	50.5	51.0	51.5
50	43.5	47.5	54.5	53.0	50.5	50.0	50.0	50.5	50.5	51.0	51.0	51.0	51.5	52.0
51	44.5	48.5	55.5	54.0	51.5	51.0	51.0	51.0	51.5	51.5	51.5	52.0	52.0	52.5
52	45.0	49.5	56.5	54.5	52.5	51.5	52.0	52.0	52.0	52.5	52.5	52.5	53.0	53.0
53	46.0	50.5	57.5	55.5	53.0	52.5	52.5	53.0	53.0	53.0	53.0	53.5	53.5	53.5
54	46.5	51.5	58.5	56.5	54.0	53.5	53.5	53.5	53.5	54.0	54.0	54.0	54.0	54.0
55	47.5	52.5	59.5	57.5	54.5	54.0	54.5	54.5	54.5	54.5	54.5	54.5	54.5	55.0
56	48.0	53.5	61.0	58.0	55.5	55.0	55.0	55.0	55.5	55.5	55.5	55.5	55.5	55.5

BSS 7351, correction factors for measurements on thin, bare gauge with a probe frequency of 120 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 120 kHz						
	Single thickness (gauge) in Inches *(mm)*						
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.270*	≥ **0.063** ≥ *1.600*
	Corrected conductivity values in % IACS						
26	21.0	26.0	28.0	27.5	26.5	26.0	26.0
27	22.0	27.5	29.0	28.5	27.5	27.0	27.0
28	23.0	29.0	30.5	29.5	28.0	28.0	28.0
29	24.0	31.0	31.5	30.5	29.0	29.0	29.0
30	25.5	32.5	32.5	31.0	30.0	30.0	30.0
31	29.0	33.5	33.5	32.5	31.0	31.0	31.0
32	31.0	35.0	34.5	33.5	32.0	32.0	32.0
33	32.0	36.0	36.0	34.0	33.0	33.0	33.0
34	33.0	37.5	37.0	35.0	34.0	34.0	34.0
35	34.0	38.5	38.0	36.0	35.0	35.0	35.0
36	35.0	40.0	39.0	37.0	36.0	36.0	36.0
37	36.0	41.0	40.0	38.0	37.0	37.0	37.0
38	37.0	42.5	41.0	39.0	38.0	38.0	38.0
39	38.0	43.5	42.0	40.0	39.0	39.0	39.0
40	39.0	45.0	43.5	41.0	40.0	40.0	40.0
41	41.0	46.0	44.0	42.0	41.0	41.0	41.0
42	43.0	47.0	45.0	42.5	42.0	42.0	42.0
43	45.5	48.0	46.0	43.5	43.0	43.0	43.0
44	47.5	49.0	47.0	44.5	44.0	44.0	44.0
45	49.5	50.0	47.5	45.5	45.0	45.0	45.0
46	51.0	51.0	48.5	46.5	46.0	46.0	46.0
47	52.0	52.0	49.5	47.5	47.0	47.0	47.0
48	53.0	53.0	50.5	48.5	48.0	48.0	48.0
49	54.0	54.0	51.5	49.5	49.0	49.0	49.0
50	55.0	55.0	52.0	50.5	50.0	50.0	50.0
51	56.0	56.0	53.0	51.5	51.0	51.0	51.0
52	57.0	57.0	54.0	52.5	52.0	52.0	52.0
53	58.0	58.0	55.0	53.5	53.0	53.0	53.0
54	58.5	59.0	56.0	54.5	54.0	54.0	54.0
55	59.5	60.0	56.5	55.0	55.0	55.0	55.0
56	60.5	61.0	57.5	56.0	56.0	56.0	56.0
57	61.5	62.0	58.5	57.0	57.0	57.0	57.0
58	62.5	63.0	59.5	58.0	58.0	58.0	58.0
59	63.5	64.0	60.5	59.0	59.0	59.0	59.0
60	64.5	65.0	61.5	60.0	60.0	60.0	60.0
61	65.5	66.0	62.0	61.0	61.0	61.0	61.0
62	67.0	67.0	63.0	62.0	62.0	62.0	62.0
63	68.0	68.0	64.0	63.0	63.0	63.0	63.0
64	69.0	69.0	65.0	64.0	64.0	64.0	64.0
65	70.0	70.0	66.0	65.0	65.0	65.0	65.0

BSS 7351, correction factors for measurements on 2014 or 2219 Clad Aluminum with a probe frequency of 120 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 120 kHz													
	Single thickness (gauge) in Inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.270*	**0.063** *1.600*	**0.080** *2.032*	**0.090** *2.286*	**0.100** *2.540*	**0.110** *2.794*	**0.125** *3.175*	**0.140** *3.556*	**0.160** *4.064*
	Corrected conductivity values in % IACS													
26	27.0	32.0	31.0	30.5	29.0	30.0	32.0	33.5	35.0	30.0	31.0	31.5	32.5	33.5
27	28.5	33.0	32.0	31.5	30.0	31.0	33.0	34.5	35.5	31.0	31.5	32.5	33.5	34.5
28	30.0	34.0	33.0	32.5	31.0	32.0	33.5	35.5	36.5	32.0	32.5	33.5	34.5	35.5
29	32.0	35.0	34.0	33.5	32.0	33.0	34.5	36.5	37.5	33.0	33.5	34.5	35.5	36.5
30	34.0	36.5	35.0	34.0	32.5	34.0	35.5	37.5	38.5	34.0	34.5	35.5	36.0	37.5
31	34.5	37.5	35.5	35.0	33.5	35.0	36.0	38.0	39.0	34.5	35.0	36.0	37.0	38.0
32	35.5	38.5	36.5	36.0	34.5	35.5	37.0	38.5	39.5	35.5	36.0	36.5	37.5	38.5
33	36.5	39.5	37.5	36.5	35.5	36.5	38.0	39.0	40.5	36.0	36.5	37.5	38.0	39.0
34	38.0	40.5	38.5	37.5	36.5	37.5	38.5	40.0	41.0	37.0	37.5	38.0	39.0	40.0
35	39.0	41.5	39.5	38.5	37.5	38.0	39.5	40.5	41.5	38.0	38.5	39.0	39.5	40.5
36	40.5	42.5	40.5	39.5	38.0	39.0	40.0	41.5	42.0	38.5	39.0	40.0	40.5	41.5
37	41.5	43.5	41.5	40.5	39.0	40.0	41.0	42.0	43.0	39.5	40.0	40.5	41.0	42.0
38	43.0	44.5	42.5	41.0	40.0	41.0	42.0	42.5	43.5	40.5	41.0	41.5	42.0	42.5
39	44.0	45.5	43.0	42.0	41.0	41.5	42.5	43.5	44.0	41.0	41.5	42.0	42.5	43.5
40	45.5	46.5	44.0	43.0	41.5	42.5	43.5	44.0	45.0	42.0	42.5	43.0	43.5	44.0
41	46.5	47.5	45.0	43.5	42.5	43.5	44.0	45.0	45.5	43.0	43.0	43.5	44.0	45.0
42	47.5	48.0	46.0	44.5	43.5	44.0	45.0	45.5	46.0	43.5	44.0	44.5	45.0	45.5
43	48.5	49.0	46.5	45.0	44.0	45.0	45.5	46.0	46.5	44.5	44.5	45.0	45.5	46.0
44	49.5	49.5	47.5	45.5	45.0	45.5	46.0	47.0	47.5	45.0	45.5	46.0	46.5	47.0
45	50.5	50.5	48.0	46.5	45.5	46.5	47.0	47.5	48.0	46.0	46.0	46.5	47.0	47.5
46	51.5	51.5	49.0	47.0	46.5	47.0	47.5	48.0	48.5	47.0	47.0	47.5	47.5	48.0
47	52.5	52.0	49.5	48.0	47.5	48.0	48.5	49.0	49.5	47.5	48.0	48.0	48.5	49.0
48	53.5	53.0	50.5	48.5	48.5	48.5	49.0	49.5	50.0	48.5	48.5	49.0	49.0	49.5
49	54.5	54.0	51.0	49.5	49.0	49.5	50.0	50.0	50.5	49.0	49.5	49.5	50.0	50.0
50	55.5	55.0	52.0	50.5	50.0	50.5	50.5	51.0	51.0	50.0	50.0	50.5	50.5	51.0
51	57.0	55.5	53.0	51.0	51.0	51.0	51.5	51.5	52.0	51.0	51.0	51.0	51.5	51.5

BSS 7351, correction factors for measurements on 2024, 7075, 7079 or 7178 Clad Aluminum with a probe frequency of 120 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 120 kHz													
	Single thickness (gauge) in Inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.270*	**0.063** *1.600*	**0.080** *2.032*	**0.090** *2.286*	**0.100** *2.540*	**0.110** *2.794*	**0.125** *3.175*	**0.140** *3.556*	**0.160** *4.064*
	Corrected conductivity values in % IACS													
26	23.0	27.5	29.5	28.5	29.0	30.0	27.5	29.0	29.5	30.0	31.0	31.5	32.5	33.5
27	24.0	29.0	30.5	29.5	30.0	31.0	28.5	30.0	30.5	31.0	31.5	32.5	33.5	34.5
28	25.5	30.0	31.5	30.5	31.0	32.0	29.5	31.0	31.5	32.0	32.5	33.5	34.5	35.5
29	27.0	31.5	32.5	31.5	32.0	33.0	30.5	32.0	32.5	33.0	33.5	34.5	35.5	36.5
30	28.5	33.0	33.5	32.5	32.5	34.0	31.5	33.0	33.5	34.0	34.5	35.5	36.0	37.5
31	30.5	34.0	34.5	33.5	33.5	35.0	32.5	33.5	34.0	34.5	35.0	36.0	37.0	38.0
32	32.0	35.5	35.5	34.0	34.5	35.5	33.5	34.0	34.5	35.5	36.0	36.5	37.5	38.5
33	33.0	36.5	36.5	35.0	35.5	36.5	34.5	35.0	35.5	36.0	36.5	37.5	38.0	39.0
34	34.0	37.5	37.5	36.0	36.5	37.5	35.5	36.0	36.5	37.0	37.5	38.0	39.0	40.0
35	35.5	39.0	38.5	37.0	37.5	38.0	36.5	37.0	37.5	38.0	38.5	39.0	39.5	40.5
36	36.5	40.0	39.5	38.0	38.0	39.0	37.5	38.0	38.0	38.5	39.0	40.0	40.5	41.5
37	38.0	41.0	40.5	39.0	39.0	40.0	38.5	38.5	39.0	39.5	40.0	40.5	41.0	42.0
38	39.0	42.5	41.5	39.5	40.0	41.0	39.0	39.5	40.0	40.5	41.0	41.5	42.0	42.5
39	40.0	43.5	42.5	40.5	41.0	41.5	40.0	40.5	41.0	41.0	41.5	42.0	42.5	43.5
40	41.5	44.5	43.5	41.5	41.5	42.5	41.0	41.5	41.5	42.0	42.5	43.0	43.5	44.0
41	43.0	46.0	44.0	42.5	42.5	43.5	42.0	42.0	42.5	43.0	43.0	43.5	44.0	45.0
42	45.0	47.0	45.0	43.0	43.5	44.0	42.5	43.0	43.5	43.5	44.0	44.5	45.0	45.5
43	46.5	48.0	45.5	44.0	44.0	45.0	43.5	44.0	44.0	44.5	44.5	45.0	45.5	46.0
44	48.5	49.0	46.5	44.5	45.0	45.5	44.5	44.5	45.0	45.0	45.5	46.0	46.5	47.0
45	50.5	50.0	47.0	45.5	45.5	46.5	45.0	45.5	45.5	46.0	46.0	46.5	47.0	47.5
46	51.5	51.0	48.0	46.5	46.5	47.0	46.0	46.5	46.5	47.0	47.0	47.5	47.5	48.0
47	52.5	52.0	49.0	47.0	47.5	48.0	47.0	47.0	47.5	47.5	48.0	48.0	48.5	49.0
48	53.5	53.0	50.0	48.0	48.5	48.5	48.0	48.0	48.0	48.5	48.5	49.0	49.0	49.5
49	54.5	54.0	50.5	49.0	49.0	49.5	48.5	49.0	49.0	49.0	49.5	49.5	50.0	50.0
50	55.5	55.0	51.5	50.0	50.0	50.5	49.5	50.0	50.0	50.0	50.0	50.5	50.5	51.0

BSS 7351, correction factors for measurements on 3003 or 6061 Clad Aluminum with a probe frequency of 120 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 120 kHz													
	Single thickness (gauge) in Inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.270*	**0.063** *1.600*	**0.080** *2.032*	**0.090** *2.286*	**0.100** *2.540*	**0.110** *2.794*	**0.125** *3.175*	**0.140** *3.556*	**0.160** *4.064*
	Corrected conductivity value in % IACS													
36	36.5	40.0	39.5	38.0	38.0	39.0	40.0	41.5	42.0	43.0	44.0	45.5	46.5	48.5
37	38.0	41.0	40.5	39.0	39.0	40.0	41.0	42.0	43.0	43.5	44.5	46.0	47.0	49.0
38	39.0	42.5	41.5	39.5	40.0	41.0	42.0	42.5	43.5	44.5	45.0	46.5	47.5	49.0
39	40.0	43.5	42.5	40.5	41.0	41.5	42.5	43.5	44.0	45.0	45.5	47.0	48.0	49.5
40	41.5	44.5	43.5	41.5	41.5	42.5	43.5	44.0	45.0	45.5	46.5	47.5	48.5	50.0
41	43.0	46.0	44.0	42.5	42.5	43.5	44.0	45.0	45.5	46.0	47.0	48.0	49.0	50.0
42	45.0	47.0	45.0	43.0	43.5	44.0	45.0	45.5	46.0	46.5	47.5	48.5	49.0	50.5
43	46.5	48.0	45.5	44.0	44.0	45.0	45.5	46.0	46.5	47.5	48.0	49.0	49.5	51.0
44	48.5	49.0	46.5	44.5	45.0	45.5	46.0	47.0	47.5	48.0	48.5	49.0	50.0	51.0
45	50.5	50.0	47.0	45.5	45.5	46.5	47.0	47.5	48.0	48.5	49.0	49.5	50.5	51.5
46	51.5	51.0	48.0	46.5	46.5	47.0	47.5	48.0	48.5	49.0	49.5	50.0	51.0	52.0
47	52.5	52.0	49.0	47.0	47.5	48.0	48.5	49.0	49.5	49.5	50.0	50.5	51.5	52.0
48	53.5	53.0	50.0	48.0	48.5	48.5	49.0	49.5	50.0	50.5	50.5	51.0	52.0	52.5
49	54.5	54.0	50.5	49.0	49.0	49.5	50.0	50.0	50.5	51.0	51.0	51.5	52.0	53.0
50	55.5	55.0	51.5	50.0	50.0	50.5	50.5	51.0	51.0	51.5	52.0	52.0	52.5	53.0
51	56.5	56.0	52.5	50.5	51.0	51.0	51.5	51.5	52.0	52.0	52.5	52.5	53.0	53.5
52	57.5	57.0	53.5	51.5	51.5	52.0	52.0	52.5	52.5	52.5	53.0	53.0	53.5	54.0
53	58.5	58.0	54.0	52.5	52.5	52.5	53.0	53.0	53.0	53.5	53.5	53.5	54.0	54.5
54	59.5	59.0	55.0	53.5	53.5	53.5	53.5	53.5	54.0	54.0	54.0	54.0	54.5	54.5
55	60.5	60.0	56.0	54.0	54.0	54.5	54.5	54.5	54.5	54.5	54.5	54.5	55.0	55.0
56	61.5	61.0	57.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.5	55.5

BSS 7351, correction factors for measurements on thin, bare gauge with a probe frequency of 240 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 240 kHz						
	Single thickness (gauge) in Inches *(mm)*						
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.270*	≥ **0.063** ≥ *1.600*
	Corrected conductivity values in % IACS						
26	28.0	28.5	27.0	26.0	26.0	26.0	26.0
27	29.0	29.5	28.0	27.0	27.0	27.0	27.0
28	30.0	30.5	29.0	28.0	28.0	28.0	28.0
29	31.5	31.5	29.5	29.0	29.0	29.0	29.0
30	33.0	32.5	30.5	30.0	30.0	30.0	30.0
31	35.0	33.5	32.0	31.0	31.0	31.0	31.0
32	36.0	34.5	33.0	32.0	32.5	32.5	32.0
33	37.5	35.5	34.0	33.0	33.5	33.5	33.0
34	38.5	36.0	34.5	34.0	34.5	34.5	34.0
35	39.5	37.0	35.5	35.0	35.5	35.5	35.5
36	40.5	38.0	36.5	36.0	36.5	36.5	36.5
37	41.5	39.0	37.5	37.0	37.5	37.5	37.5
38	42.5	40.0	38.5	38.0	38.5	38.5	38.5
39	44.0	40.5	39.5	39.0	39.5	39.5	39.5
40	45.0	41.5	40.5	40.0	40.5	40.5	40.5
41	46.0	42.5	41.5	41.0	41.5	41.5	41.5
42	46.5	44.0	42.5	42.0	42.5	42.5	42.5
43	47.5	45.0	43.0	43.0	43.5	43.5	43.5
44	48.0	46.5	44.0	44.0	44.5	44.5	44.5
45	49.0	47.5	45.0	45.0	45.5	45.5	45.5
46	50.0	48.5	46.0	46.0	46.5	46.5	46.5
47	51.0	49.5	47.0	47.0	47.5	47.5	47.5
48	52.0	50.0	48.0	48.0	48.5	48.5	48.5
49	53.0	51.0	49.0	49.0	49.5	49.5	49.5
50	54.5	52.0	50.0	50.0	50.5	50.5	50.5
51	55.5	52.5	51.0	51.0	51.0	51.5	51.0
52	56.5	53.5	52.0	52.0	52.0	52.0	52.0
53	57.5	54.5	53.0	53.0	53.0	53.0	53.0
54	58.5	55.5	54.0	54.0	54.0	54.0	54.0
55	60.0	56.0	55.0	55.0	55.0	55.0	55.0
56	61.0	57.0	56.0	56.0	56.0	56.0	56.0
57	62.0	58.0	57.0	57.0	57.0	57.0	57.0
58	63.0	58.5	58.0	58.0	58.0	58.0	58.0
59	64.0	59.5	59.0	59.0	59.0	59.0	59.0
60	65.5	60.5	60.0	60.0	60.0	60.0	60.0
61	66.0	61.5	61.0	61.0	61.0	61.0	61.0
62	67.0	62.5	62.0	62.0	62.0	62.0	62.0
63	68.0	63.5	63.0	63.0	63.0	63.0	63.0
64	68.5	64.5	64.0	64.0	64.0	64.0	64.0
65	69.5	65.5	65.0	65.0	65.0	65.0	65.0

BSS 7351, correction factors for measurements on 2014 or 2219 Clad Aluminum with a probe frequency of 240 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 240 kHz													
	Single thickness (gauge) in Inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.270*	**0.063** *1.600*	**0.080** *2.032*	**0.090** *2.286*	**0.100** *2.540*	**0.110** *2.794*	**0.125** *3.175*	**0.140** *3.556*	**0.160** *4.064*
	Corrected conductivity values in % IACS													
26	32.5	33.0	31.0	33.0	31.5	33.5	36.0	39.5	41.5	33.5	34.5	36.0	37.5	39.5
27	33.5	34.0	32.0	34.0	32.5	34.5	37.0	40.0	42.0	34.5	35.5	37.0	38.5	40.0
28	34.5	35.0	33.0	34.5	33.5	35.0	37.5	41.0	43.0	35.5	36.0	37.5	39.0	41.0
29	35.5	36.0	33.5	35.5	34.0	36.0	38.5	41.5	43.5	36.0	37.0	38.5	40.0	41.5
30	36.5	37.0	34.5	36.5	35.0	37.0	39.0	42.5	44.0	37.0	37.5	39.0	40.5	42.5
31	37.5	37.5	35.5	37.5	36.5	38.0	40.0	42.0	44.0	37.5	38.0	39.5	40.5	42.0
32	38.5	38.0	36.5	38.5	37.0	39.0	41.0	42.5	44.0	38.0	39.0	40.0	41.0	42.5
33	39.5	39.0	37.0	39.0	38.0	39.5	41.5	43.0	44.5	39.0	39.5	40.5	41.5	43.0
34	40.0	39.5	38.0	40.0	38.5	40.0	42.0	43.5	45.0	39.5	40.0	41.5	42.5	43.5
35	41.0	40.5	39.0	40.5	39.5	41.0	43.0	44.0	45.5	40.5	41.0	42.0	43.0	44.0
36	42.0	41.5	39.5	41.5	40.5	41.5	43.5	44.5	46.0	41.0	41.5	42.5	43.5	44.5
37	42.5	42.5	40.5	42.0	41.0	42.5	44.0	45.5	46.5	42.0	42.5	43.5	44.0	45.5
38	43.5	43.0	41.0	43.0	42.0	43.0	44.5	46.0	47.0	42.5	43.0	44.0	44.5	46.0
39	44.5	44.0	42.0	43.5	42.5	44.0	45.5	46.5	47.5	43.5	44.0	44.5	45.5	46.5
40	45.0	45.0	43.0	44.5	43.5	44.5	46.0	47.0	48.0	44.0	44.5	45.5	46.0	47.0
41	45.5	45.5	43.5	45.0	44.0	45.0	46.5	47.5	48.5	45.0	45.5	46.0	46.5	47.5
42	46.0	46.0	44.5	45.5	45.0	46.0	47.0	48.0	49.0	45.5	46.0	46.5	47.5	48.0
43	46.0	46.0	45.0	46.5	45.5	46.5	48.0	49.0	49.5	46.0	46.5	47.0	48.0	49.0
44	46.5	46.5	46.0	47.0	46.5	47.5	48.5	49.5	50.5	47.0	47.0	48.0	48.5	49.5
45	46.5	46.5	46.5	48.0	47.5	48.0	49.0	50.0	51.0	47.5	48.0	48.5	49.0	50.0
46	47.0	47.5	47.0	48.5	48.0	48.5	49.5	50.5	51.0	48.0	48.5	49.0	49.5	50.5
47	48.0	48.0	48.0	49.0	48.5	49.0	50.0	51.0	51.5	49.0	49.0	49.5	50.0	51.0
48	49.0	49.0	48.5	50.0	49.5	50.0	50.5	51.5	52.0	49.5	49.5	50.0	50.5	51.5
49	50.0	50.0	49.5	50.5	50.0	50.5	51.0	51.5	52.0	50.0	50.5	50.5	51.0	51.5
50	51.0	50.5	50.0	51.0	50.5	51.0	51.5	52.0	52.5	50.5	51.0	51.5	51.5	52.0
51	51.5	51.5	51.0	52.0	51.5	52.0	52.0	52.5	53.0	51.5	51.5	52.0	52.0	52.5

BSS 7351, correction factors for measurements on 2024, 7075, 7079 or 7178 Clad Aluminum with a probe frequency of 240 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 240 kHz													
	Single thickness (gauge) in Inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.270*	**0.063** *1.600*	**0.080** *2.032*	**0.090** *2.286*	**0.100** *2.540*	**0.110** *2.794*	**0.125** *3.175*	**0.140** *3.556*	**0.160** *4.064*
	Corrected conductivity values in % IACS													
26	29.0	28.5	28.0	29.5	31.5	33.5	29.5	32.0	32.5	33.5	34.5	36.0	37.5	39.5
27	30.5	29.5	29.0	30.0	32.5	34.5	30.0	32.5	33.5	34.5	35.5	37.0	38.5	40.0
28	31.5	30.5	30.0	31.0	33.5	35.0	31.0	33.5	34.5	35.5	36.0	37.5	39.0	41.0
29	33.0	31.5	31.0	32.0	34.0	36.0	32.0	34.0	35.0	36.0	37.0	38.5	40.0	41.5
30	34.0	32.5	31.5	33.0	35.0	37.0	33.0	35.0	36.0	37.0	37.5	39.0	40.5	42.5
31	35.0	33.5	33.0	34.0	36.5	38.0	34.0	35.5	36.5	37.5	38.0	39.5	40.5	42.0
32	36.0	34.5	34.0	35.0	37.0	39.0	35.0	36.5	37.5	38.0	39.0	40.0	41.0	42.5
33	37.0	35.5	34.5	36.0	38.0	39.5	36.0	37.5	38.0	39.0	39.5	40.5	41.5	43.0
34	38.0	36.0	35.5	36.5	38.5	40.0	36.5	38.0	39.0	39.5	40.0	41.5	42.5	43.5
35	39.0	37.0	36.5	37.5	39.5	41.0	37.5	39.0	39.5	40.5	41.0	42.0	43.0	44.0
36	40.5	38.0	37.0	38.5	40.5	41.5	38.5	40.0	40.5	41.0	41.5	42.5	43.5	44.5
37	41.5	39.0	38.0	39.0	41.0	42.5	39.0	40.5	41.5	42.0	42.5	43.5	44.0	45.5
38	42.5	40.0	39.0	40.0	42.0	43.0	40.0	41.5	42.0	42.5	43.0	44.0	44.5	46.0
39	43.5	40.5	40.0	41.0	42.5	44.0	41.0	42.5	43.0	43.5	44.0	44.5	45.5	46.5
40	44.5	41.5	40.5	42.0	43.5	44.5	41.5	43.0	43.5	44.0	44.5	45.5	46.0	47.0
41	45.5	42.5	41.5	42.5	44.0	45.0	42.5	44.0	44.5	45.0	45.5	46.0	46.5	47.5
42	46.0	43.5	42.5	43.5	45.0	46.0	43.5	44.5	45.0	45.5	46.0	46.5	47.5	48.0
43	46.5	44.5	43.5	44.0	45.5	46.5	44.0	45.5	45.5	46.0	46.5	47.0	48.0	49.0
44	47.0	45.5	44.0	45.0	46.5	47.5	45.0	46.0	46.5	47.0	47.0	48.0	48.5	49.5
45	47.5	46.5	45.0	46.0	47.5	48.0	45.5	46.5	47.0	47.5	48.0	48.5	49.0	50.0
46	48.0	47.0	46.0	46.5	48.0	48.5	46.5	47.5	47.5	48.0	48.5	49.0	49.5	50.5
47	49.5	48.0	47.0	47.5	48.5	49.0	47.5	48.0	48.5	49.0	49.0	49.5	50.0	51.0
48	50.5	49.0	47.5	48.0	49.5	50.0	48.0	49.0	49.0	49.5	49.5	50.0	50.5	51.5
49	51.5	50.0	48.5	49.0	50.0	50.5	49.0	49.5	50.0	50.0	50.5	50.5	51.0	51.5
50	52.5	51.0	49.5	50.0	50.5	51.0	49.5	50.5	50.5	50.5	51.0	51.5	51.5	52.0

BSS 7351, correction factors for measurements on 3003 or 6061 Clad Aluminum with a probe frequency of 240 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 240 kHz													
	Single thickness (gauge) in Inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.270*	**0.063** *1.600*	**0.080** *2.032*	**0.090** *2.286*	**0.100** *2.540*	**0.110** *2.794*	**0.125** *3.175*	**0.140** *3.556*	**0.160** *4.064*
	Corrected conductivity value in % IACS													
36	40.5	38.0	37.0	38.5	40.5	41.5	43.5	44.5	46.0	47.0	48.5	50.0	52.0	54.5
37	41.5	39.0	38.0	39.0	41.0	42.5	44.0	45.5	46.5	47.5	48.5	50.5	52.0	54.5
38	42.5	40.0	39.0	40.0	42.0	43.0	44.5	46.0	47.0	48.0	49.0	50.5	52.5	54.5
39	43.5	40.5	40.0	41.0	42.5	44.0	45.5	46.5	47.5	48.5	49.5	51.0	52.5	54.5
40	44.5	41.5	40.5	42.0	43.5	44.5	46.0	47.0	48.0	49.0	49.5	51.0	52.5	54.5
41	45.5	42.5	41.5	42.5	44.0	45.0	46.5	47.5	48.5	49.5	50.0	51.5	53.0	54.5
42	46.0	43.5	42.5	43.5	45.0	46.0	47.0	48.0	49.0	50.0	51.0	52.0	53.5	55.0
43	46.5	44.5	43.5	44.0	45.5	46.5	48.0	49.0	49.5	50.5	51.5	52.5	54.0	56.0
44	47.0	45.5	44.0	45.0	46.5	47.5	48.5	49.5	50.5	51.0	52.0	53.5	54.5	56.5
45	47.5	46.5	45.0	46.0	47.5	48.0	49.0	50.0	51.0	51.5	52.5	54.0	55.0	57.0
46	48.0	47.0	46.0	46.5	48.0	48.5	49.5	50.5	51.0	52.0	53.0	54.0	55.0	56.5
47	49.5	48.0	47.0	47.5	48.5	49.0	50.0	51.0	51.5	52.5	53.0	54.0	55.0	56.5
48	50.5	49.0	47.5	48.0	49.5	50.0	50.5	51.5	52.0	52.5	53.0	54.0	55.0	56.0
49	51.5	50.0	48.5	49.0	50.0	50.5	51.0	51.5	52.0	52.5	53.5	54.0	55.0	56.0
50	52.5	51.0	49.5	50.0	50.5	51.0	51.5	52.0	52.5	53.0	53.5	54.0	54.5	55.5
51	53.5	52.0	50.5	50.5	51.5	52.0	52.0	52.5	53.0	53.0	53.5	54.0	54.5	55.5
52	54.5	53.0	51.0	51.5	52.0	52.5	52.5	53.0	53.0	53.5	53.5	54.0	54.5	55.0
53	55.5	54.0	52.0	52.0	53.0	53.0	53.5	53.5	53.5	53.5	54.0	54.0	54.5	55.0
54	56.5	55.0	53.0	53.0	53.5	53.5	54.0	53.5	54.0	54.0	54.0	54.0	54.5	54.5
55	57.5	56.0	53.5	54.0	54.0	54.5	54.5	54.0	54.0	54.0	54.0	54.0	54.5	54.5
56	58.5	57.0	54.5	54.5	55.0	55.0	55.0	54.5	54.5	54.5	54.5	54.0	54.0	54.0

BSS 7351, correction factors for measurements on thin, bare gauge with a probe frequency of 480 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 480 kHz						
	Single thickness (gauge) in Inches *(mm)*						
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.270*	≥ **0.063** ≥ *1.600*
	Corrected conductivity values in % IACS						
26	28.0	28.5	27.0	26.0	26.0	26.0	26.0
27	29.0	29.5	28.0	27.0	27.0	27.0	27.0
28	30.0	30.5	29.0	28.0	28.0	28.0	28.0
29	31.5	31.5	29.5	29.0	29.0	29.0	29.0
30	33.0	32.5	30.5	30.0	30.0	30.0	30.0
31	35.0	33.5	32.0	31.0	31.0	31.0	31.0
32	36.0	34.5	33.0	32.0	32.5	32.5	32.0
33	37.5	35.5	34.0	33.0	33.5	33.5	33.0
34	38.5	36.0	34.5	34.0	34.5	34.5	34.0
35	39.5	37.0	35.5	35.0	35.5	35.5	35.5
36	40.5	38.0	36.5	36.0	36.5	36.5	36.5
37	41.5	39.0	37.5	37.0	37.5	37.5	37.5
38	42.5	40.0	38.5	38.0	38.5	38.5	38.5
39	44.0	40.5	39.5	39.0	39.5	39.5	39.5
40	45.0	41.5	40.5	40.0	40.5	40.5	40.5
41	46.0	42.5	41.5	41.0	41.5	41.5	41.5
42	46.5	44.0	42.5	42.0	42.5	42.5	42.5
43	47.5	45.0	43.0	43.0	43.5	43.5	43.5
44	48.0	46.5	44.0	44.0	44.5	44.5	44.5
45	49.0	47.5	45.0	45.0	45.5	45.5	45.5
46	50.0	48.5	46.0	46.0	46.5	46.5	46.5
47	51.0	49.5	47.0	47.0	47.5	47.5	47.5
48	52.0	50.0	48.0	48.0	48.5	48.5	48.5
49	53.0	51.0	49.0	49.0	49.5	49.5	49.5
50	54.5	52.0	50.0	50.0	50.5	50.5	50.5
51	55.5	52.5	51.0	51.0	51.0	51.5	51.0
52	56.5	53.5	52.0	52.0	52.0	52.0	52.0
53	57.5	54.5	53.0	53.0	53.0	53.0	53.0
54	58.5	55.5	54.0	54.0	54.0	54.0	54.0
55	60.0	56.0	55.0	55.0	55.0	55.0	55.0
56	61.0	57.0	56.0	56.0	56.0	56.0	56.0
57	62.0	58.0	57.0	57.0	57.0	57.0	57.0
58	63.0	58.5	58.0	58.0	58.0	58.0	58.0
59	64.0	59.5	59.0	59.0	59.0	59.0	59.0
60	65.5	60.5	60.0	60.0	60.0	60.0	60.0
61	66.0	61.5	61.0	61.0	61.0	61.0	61.0
62	67.0	62.5	62.0	62.0	62.0	62.0	62.0
63	68.0	63.5	63.0	63.0	63.0	63.0	63.0
64	68.5	64.5	64.0	64.0	64.0	64.0	64.0
65	69.5	65.5	65.0	65.0	65.0	65.0	65.0

BSS 7351, correction factors for measurements on 2014 or 2219 Clad Aluminum with a probe frequency of 480 kHz

Uncorrected conductivity values in % IACS	**Probe ES40, probe frequency 480 kHz**													
	Single thickness (gauge) in Inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.270*	**0.063** *1.600*	**0.080** *2.032*	**0.090** *2.286*	**0.100** *2.540*	**0.110** *2.794*	**0.125** *3.175*	**0.140** *3.556*	**0.160** *4.064*
	Corrected conductivity values in % IACS													
26	33.0	35.5	34.5	38.0	36.0	39.0	42.5	47.5	50.5	39.0	40.5	42.5	45.0	47.5
27	33.5	36.0	35.0	38.5	36.5	39.5	43.5	48.0	51.0	39.5	41.0	43.0	45.5	48.0
28	34.5	37.0	36.0	39.5	37.5	40.0	44.0	48.5	51.5	40.0	41.5	43.5	45.5	48.5
29	35.0	37.5	36.5	40.0	38.0	41.0	44.5	49.0	51.5	40.5	42.0	44.0	46.0	49.0
30	35.5	38.5	37.5	41.0	38.5	41.5	45.0	49.0	52.0	41.0	42.5	44.5	46.5	49.0
31	37.0	39.5	38.5	41.5	39.5	42.5	45.5	49.5	52.5	41.5	43.0	45.0	47.0	49.5
32	37.5	40.0	39.0	42.0	40.0	43.0	46.0	50.0	52.5	42.0	43.5	45.5	47.5	50.0
33	38.5	40.5	40.0	43.0	40.5	43.5	46.5	50.5	53.0	42.5	44.0	46.0	47.5	50.5
34	39.0	41.5	40.5	43.5	41.5	44.0	47.0	50.5	53.0	43.0	44.5	46.5	48.0	50.5
35	39.5	42.0	41.5	44.0	42.0	44.5	47.5	51.0	53.5	44.0	45.0	47.0	48.5	51.0
36	40.5	43.0	42.0	44.5	42.5	45.0	48.0	51.5	53.5	44.5	45.5	47.5	49.0	51.5
37	41.0	43.5	42.5	45.0	43.0	45.5	48.0	51.5	54.0	45.0	46.0	48.0	49.5	51.5
38	41.5	44.0	43.5	46.0	44.0	46.0	48.5	52.0	54.0	45.5	46.5	48.5	50.0	52.0
39	42.5	45.0	44.0	46.5	44.5	46.5	49.0	52.5	54.5	46.5	47.5	49.0	50.5	52.5
40	43.0	45.5	45.0	47.0	45.0	47.0	49.5	52.5	54.5	47.0	48.0	49.5	51.0	52.5
41	43.5	46.0	45.5	47.5	46.0	47.5	50.0	53.0	55.0	47.5	48.5	49.5	51.0	53.0
42	44.5	46.5	46.0	48.0	46.5	48.0	50.0	53.0	54.5	48.0	49.0	50.0	51.5	53.0
43	45.0	47.5	46.5	48.5	47.5	48.5	50.5	53.0	54.5	48.5	49.0	50.5	51.5	53.0
44	45.5	48.0	47.0	49.0	48.0	49.0	50.5	53.0	54.5	49.0	49.5	50.5	52.0	53.0
45	46.0	48.5	47.5	49.5	49.0	49.5	51.0	53.5	54.5	49.5	50.0	51.0	52.0	53.5
46	47.0	49.0	48.5	50.0	49.5	50.0	51.5	53.5	54.5	50.0	50.5	51.5	52.5	53.5
47	47.5	49.5	49.0	50.5	50.0	50.5	51.5	53.5	55.0	50.5	51.0	52.0	52.5	53.5
48	48.0	50.0	49.5	51.0	50.5	51.0	52.0	54.0	55.0	51.0	51.5	52.0	53.0	54.0
49	48.5	51.0	50.0	51.5	51.0	51.5	52.5	54.0	55.0	51.5	52.0	52.5	53.0	54.0
50	49.5	51.5	51.0	52.0	51.5	52.0	53.0	54.5	55.0	52.0	52.5	53.0	53.5	54.5
51	50.0	52.0	51.5	52.5	52.0	52.5	53.0	54.5	55.5	52.5	53.0	53.5	54.0	54.5

BSS 7351, correction factors for measurements on 2024, 7075, 7079 or 7178 Clad Aluminum with a probe frequency of 480 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 480 kHz													
	Single thickness (gauge) in Inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.270*	**0.063** *1.600*	**0.080** *2.032*	**0.090** *2.286*	**0.100** *2.540*	**0.110** *2.794*	**0.125** *3.175*	**0.140** *3.556*	**0.160** *4.064*
	Corrected conductivity values in % IACS													
26	28.0	27.0	29.0	32.5	36.0	39.0	32.0	36.0	37.5	39.0	40.5	42.5	45.0	47.5
27	29.0	28.0	30.0	33.0	36.5	39.5	32.5	36.5	38.0	39.5	41.0	43.0	45.5	48.0
28	30.0	29.0	31.0	34.0	37.5	40.0	33.5	37.5	38.5	40.0	41.5	43.5	45.5	48.5
29	31.0	29.5	32.0	34.5	38.0	41.0	34.5	38.0	39.0	40.5	42.0	44.0	46.0	49.0
30	31.5	30.5	32.5	35.5	38.5	41.5	35.0	38.5	39.5	41.0	42.5	44.5	46.5	49.0
31	33.0	32.0	34.0	36.5	39.5	42.5	36.5	38.5	40.0	41.5	43.0	45.0	47.0	49.5
32	33.5	33.0	35.0	37.0	40.0	43.0	37.0	39.5	40.5	42.0	43.5	45.5	47.5	50.0
33	34.5	34.0	35.5	38.0	40.5	43.5	38.0	40.0	41.5	42.5	44.0	46.0	47.5	50.5
34	35.5	34.5	36.5	38.5	41.5	44.0	38.5	40.5	42.0	43.0	44.5	46.5	48.0	50.5
35	36.5	35.5	37.5	39.5	42.0	44.5	39.5	41.5	42.5	44.0	45.0	47.0	48.5	51.0
36	37.0	36.5	38.0	40.5	42.5	45.0	40.0	42.0	43.5	44.5	45.5	47.5	49.0	51.5
37	38.0	37.5	39.0	41.0	43.0	45.5	41.0	43.0	44.0	45.0	46.0	48.0	49.5	51.5
38	39.0	38.0	40.0	42.0	44.0	46.0	41.5	43.5	44.5	45.5	46.5	48.5	50.0	52.0
39	40.0	39.0	40.5	42.5	44.5	46.5	42.0	44.5	45.5	46.5	47.5	49.0	50.5	52.5
40	40.5	40.0	41.5	43.5	45.0	47.0	43.0	45.0	46.0	47.0	48.0	49.5	51.0	52.5
41	41.5	41.0	42.5	44.0	46.0	47.5	43.5	45.5	46.5	47.5	48.5	49.5	51.0	53.0
42	42.5	42.0	43.0	44.5	46.5	48.0	44.5	46.0	47.0	48.0	49.0	50.0	51.5	53.0
43	43.0	42.5	44.0	45.5	47.5	48.5	45.0	47.0	47.5	48.5	49.0	50.5	51.5	53.0
44	44.0	43.5	44.5	46.0	48.0	49.0	45.5	47.5	48.0	49.0	49.5	50.5	52.0	53.0
45	44.5	44.5	45.5	46.5	49.0	49.5	46.5	48.0	48.5	49.5	50.0	51.0	52.0	53.5
46	45.5	45.5	46.5	47.5	49.5	50.0	47.0	48.5	49.0	50.0	50.5	51.5	52.5	53.5
47	46.5	46.5	47.0	48.0	50.0	50.5	48.0	49.0	50.0	50.5	51.0	52.0	52.5	53.5
48	47.5	47.0	48.0	48.5	50.5	51.0	48.5	50.0	50.5	51.0	51.5	52.0	53.0	54.0
49	48.0	48.0	48.5	49.5	51.0	51.5	49.0	50.5	51.0	51.5	52.0	52.5	53.0	54.0
50	49.0	49.0	49.5	50.0	51.5	52.0	50.0	51.0	51.5	52.0	52.5	53.0	53.5	54.5

BSS 7351, correction factors for measurements on 3003 or 6061 Clad Aluminum with a probe frequency of 480 kHz

Uncorrected conductivity values in % IACS	Probe ES40, probe frequency 480 kHz													
	Single thickness (gauge) in Inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.270*	**0.063** *1.600*	**0.080** *2.032*	**0.090** *2.286*	**0.100** *2.540*	**0.110** *2.794*	**0.125** *3.175*	**0.140** *3.556*	**0.160** *4.064*
	Corrected conductivity value in % IACS													
36	37.0	36.5	38.0	40.5	42.5	45.0	48.0	51.5	53.5	56.0	58.0	61.5	65.0	69.5
37	38.0	37.5	39.0	41.0	43.0	45.5	48.0	51.5	54.0	56.0	58.5	61.5	65.0	69.5
38	39.0	38.0	40.0	42.0	44.0	46.0	48.5	52.0	54.0	56.5	58.5	61.5	64.5	69.0
39	40.0	39.0	40.5	42.5	44.5	46.5	49.0	52.5	54.5	56.5	58.5	61.5	64.5	68.5
40	40.5	40.0	41.5	43.5	45.0	47.0	49.5	52.5	54.5	56.5	58.5	61.5	64.5	68.5
41	41.5	41.0	42.5	44.0	46.0	47.5	50.0	53.0	55.0	56.5	58.5	61.0	64.0	67.5
42	42.5	42.0	43.0	44.5	46.5	48.0	50.0	53.0	54.5	56.5	58.0	60.5	63.5	66.5
43	43.0	42.5	44.0	45.5	47.5	48.5	50.5	53.0	54.5	56.5	58.0	60.0	62.5	65.5
44	44.0	43.5	44.5	46.0	48.0	49.0	50.5	53.0	54.5	56.0	57.5	59.5	62.0	65.0
45	44.5	44.5	45.5	46.5	49.0	49.5	51.0	53.5	54.5	56.0	57.5	59.0	61.0	64.0
46	45.5	45.5	46.5	47.5	49.5	50.0	51.5	53.5	54.5	56.0	57.0	59.0	61.0	63.5
47	46.5	46.5	47.0	48.0	50.0	50.5	51.5	53.5	55.0	56.0	57.0	59.0	60.5	62.5
48	47.5	47.0	48.0	48.5	50.5	51.0	52.0	54.0	55.0	56.0	57.0	58.5	60.0	62.0
49	48.0	48.0	48.5	49.5	51.0	51.5	52.5	54.0	55.0	56.0	57.0	58.5	59.5	61.5
50	49.0	49.0	49.5	50.0	51.5	52.0	53.0	54.5	55.0	56.0	57.0	58.0	59.5	61.0
51	50.0	50.0	50.0	50.5	52.0	52.5	53.0	54.5	55.5	56.0	57.0	58.0	59.0	60.5
52	51.0	50.5	51.0	51.0	53.0	53.0	53.5	55.0	55.5	56.0	56.5	57.5	58.5	60.0
53	51.5	51.5	51.5	52.0	53.5	53.5	54.0	55.0	55.5	56.0	56.5	57.5	58.0	59.5
54	52.5	52.5	52.5	52.5	54.0	54.0	54.0	55.0	55.5	56.0	56.5	57.0	58.0	58.5
55	53.5	53.5	53.0	53.0	54.5	54.5	54.5	55.5	56.0	56.0	56.5	57.0	57.5	58.0
56	54.5	54.0	54.0	54.0	55.0	55.0	55.0	55.5	56.0	56.0	56.5	56.5	57.0	57.5

5 Settings

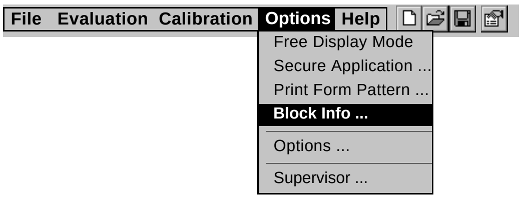
5.1 Test Information (Operator, Product, Batch, Order, etc.)

Test information such as operator, product description, product no., batch no., order no., manufacturing date, etc. can be entered for each measurement data block. To this end, so-called information parameters must be pre-defined, which are then available to each block, and which can be filled in correspondingly during or after the measurement (entry of the operator name, the order number, etc.). The information parameters are available to all applications and blocks.

5.1.1 Defining Information Parameters

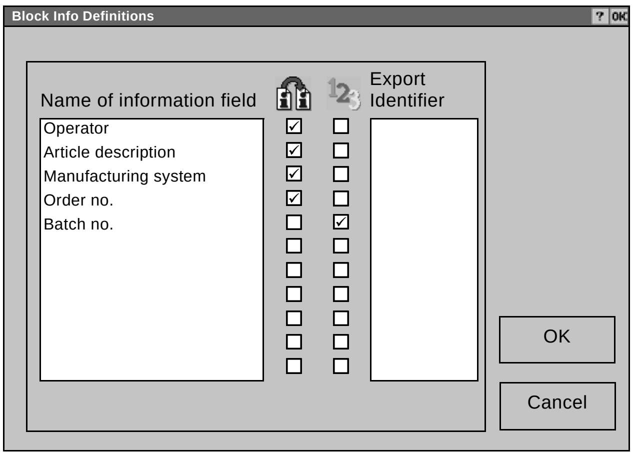
Procedure

1. Call the dialog window ***Block Info Definitions*****:**



Tap **Options / Block Info ...** on the display in succession using the stylus.

2. Defining the information parameters:



Example for the definition of 5 information parameters

Entering the parameter:
Enter the desired parameter designations (example operator, Article description, Batch no., Manufacturing System, etc.) under **Name of information field**. Maximum character length 20 characters per designation. Up to 10 parameters can be defined.

Enable control boxes:

☑ = enabled.

☐ = disabled.

During the measurement, the test information (e.g., Weidgen as operator name) is transferred automatically to all subsequent blocks (continuous block numbers).

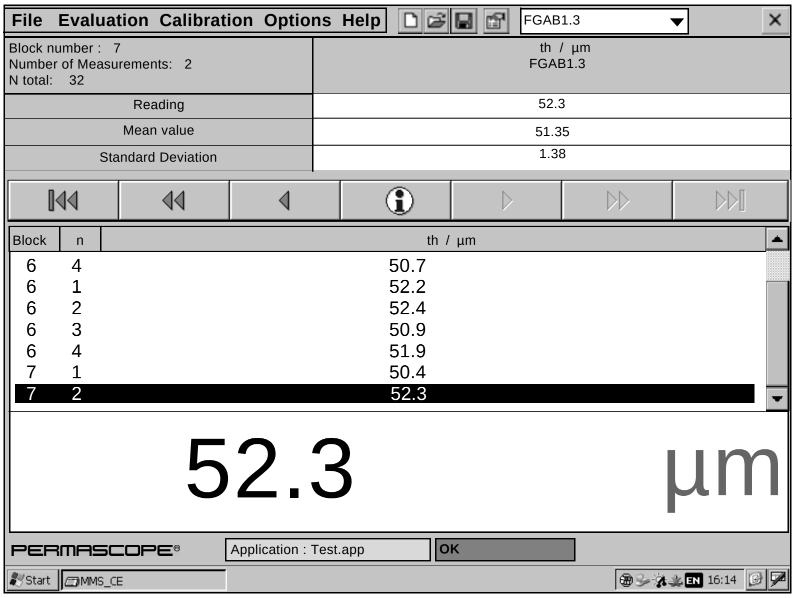
Change the entry field for the test information to a purely numerical entry field (only numeric entries are possible).

Export Identifier Entry of the respective field variables. Required only for export, such that, for example, an evaluation program on the PC can integrate this test information appropriately. The field variables required to this end should be obtained from the description of the respective program.

3. Saving entries/settings:

Tap the **OK** button using the stylus.

The dialog window *Block Info Definitions* closes.



The button appears on the measurement screen.

5.1.2 Entering the Test Information

Test information always refers to a measurement data block and can be entered only if the information parameters have been defined earlier (see previous section). Only then will the button be visible on the measurement screen. The entry of the test information is carried our for the selected block in the open application.

1. Select block:

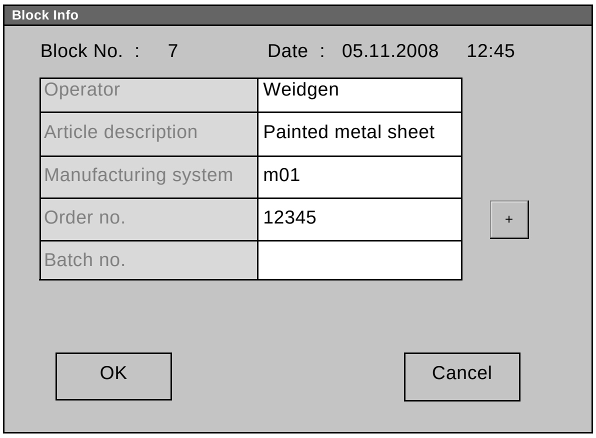
Use the stylus to tap the or buttons for moving block by block forward or back. This step does not apply for new (empty) applications.

2. Calling the window *Block Info*:

This call is done directly from the measurement screen.

Tap the button on the display using the stylus.

3. Entering information:

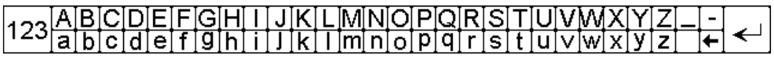


Example for test information.

Button appears for numeric entry fields. Tapping the button increases the number in the entry field by one.

Example:
The text input in the window *Block Info* occurred before the first measurement. According to the settings in the lower Figure on page 5-3, the test information (text entries) "Weidgen", "Painted metal sheet", "m01" and "12345" is transferred automatically to all subsequently measured blocks. Thus, in this example, only the batch number per block needs to be entered. This can also be done later, after ending the measurement series.

Entry bar



Double-tap in the light field, to the right of the desired parameter. Enter the text/numbers for the respective parameter.

If required, change the entry bar to letters/characters: Tap the left ABC or 123 button.

4. Saving test information:

Tap the **OK** button using the stylus.
The entries are saved for the current block.

The entries are transferred automatically to the subsequent blocks (directly following continuous block numbers) corresponding to the parameter definitions (see previous section).

Saving test information

The window *Block Info* closes.

Integrating the block information into an evaluation print form see page 5-9.

5.2 Documentation

For the presentation of measurement data and evaluations on print forms, any number of print form templates can be set up in the FISCHERSCOPE® MMS® PC2. The desired print form template can then be assigned to each application.

- Setting up a print form template, 🗐 5-7.
- Editing a print form template, 🗐 5-11.
- Assigning a print form template to an application, 🗐 5-12.

5.2.1 Setting Up a Print Form Template

Print form templates for:

- Block result

- Final result

- Export of a print form as a text file, for example

The FISCHERSCOPE® MMS® PC2 offers the two statistical evaluation types block result and final result. Print forms can be set up for them.

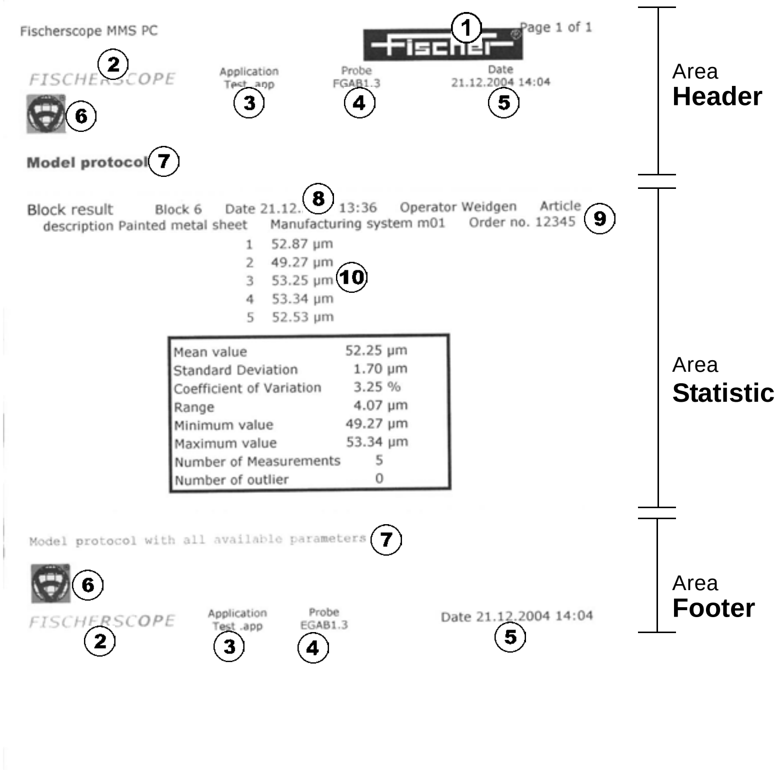
- **Block Result**: Measurement data are evaluated related to blocks (measurement data are separated into groups, application-related setting).
- **Final Result**: Evaluation of all measurement data or across a selection of blocks or measurement data.

These two types of evaluations require separate print form templates. A separate print form template is also required for exporting a print form, e.g., into a text file. Setting up these three types of templates is carried out in a special dialog window.

- Description of the display parameters and characteristic quantities beginning at 🗐 5-13.
- Procedure beginning at 🗐 5-9.

Fundamentally, a print form template can be comprised of the 3 areas header, statistics and footer.

Various display parameters/characteristic quantities are available for all 3 areas:



Examples of a printed print form using a print form template for block result.

1 **Fischer Logo**
Company logo of Helmut Fischer GmbH

2 **Device name**
FISCHERSCOPE for the instrument model FISCHERSCOPE® MMS® PC2.

3 **Application name**
Designation of the application file (measurement application file; example Test.app).

4 **Probe name**

5 **Date/Time**
Date and time of the print form setup.

6 **Image**
Integrating a desired image (e.g., own company logo, a sketch of the specimen).
Procedure see page 5-9.

7 **Information**
Text line, e.g., print form title. Text input see page 5-9.

8 **Date/Time**
Date and time of the block closure.

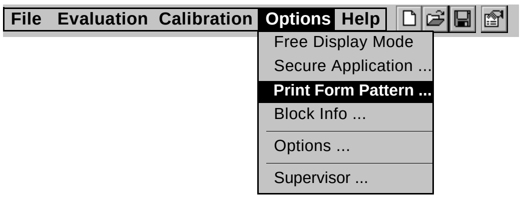
9 **Block information**
Entries (test information) that are assigned to the blocks.
Procedure see beginning on page 5-9.

10 **Readings**
Single readings of the block.

The presentations on the screen under **Evaluation/Block Result** and **Evaluation/Final Result** differ slightly from the actual default printout.

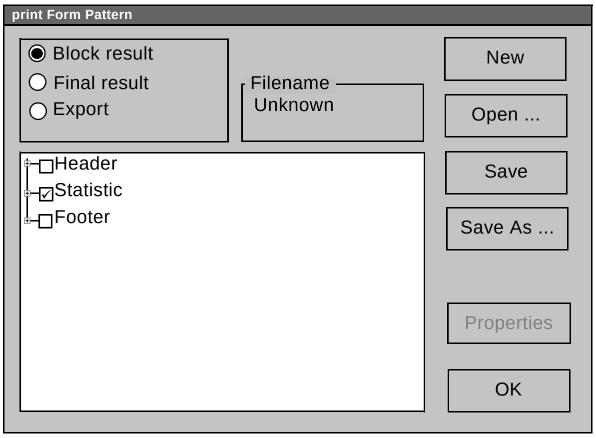
Procedure

1. Call dialog window *Print Form Pattern* :



Use the stylus to tap **Options / Print Form Pattern...** in succession on the display.

2. Setting up a print form template:



Display of the parameters/characteristic quantities list:
Tap the plus sign ⊞.
A tree structure similar to Windows Explorer will appear.

Close list: Tap the minus sign ⊟.

Entries for the parameters "Information" and "Image" in the parameter list:

1. Tap the word "Information" or "Image" in the list using the stylus. The word will be highlighted in blue.
2. Tap the **Properties...** button. An entry window opens.
3. **Information:** Enter the desired text (e.g., test print form for the Muster Company). The maximum number of characters that can be shown on the print form depends on the printer settings (can be up to 72 characters).

   Image: Enter the path where the image file is located (e.g., \My Documents\Logo.gif or \Network\LAN\Logo.gif). The file formats jpg, gif and bmp can be integrated.
4. Tap the **OK** button to save the entries in the print form template.

window *Print Form Pattern*

1. **Selecting the type of print form:** Tap the desired parameter using the stylus.
2. Tap the **New** button using the stylus.
3. **Selecting the parameters/ characteristic quantities** that are to be used in the print form.

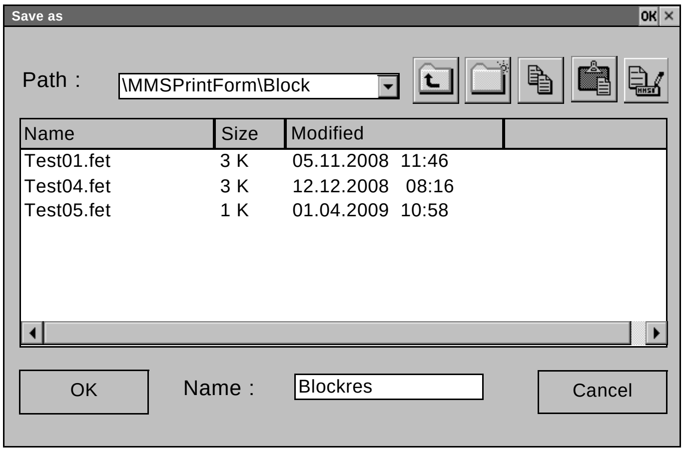
A description of the parameters/characteristic quantities can be found beginning on page 5-13.

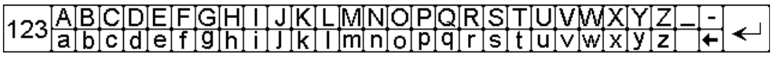
Parameter selection: Tap the box to the left of the parameter/characteristic quantity.

☑ = Parameter/characteristic quantity enabled.

☐ = Parameter/characteristic quantity disabled.

3. Saving the print form template:





1. Tap the **Save As...** button using the stylus. The window *Save As...* opens.
2. Assigning file names: **Blockres** (sample name) Tap the letters in succession in the entry bar at the lower display edge using the stylus.

   If necessary, change the entry bar to letters/characters: Tap the left control button **ABC** or **123**.
3. Tap the **OK** button using the stylus. The window *Save As...* closes.

4. Closing the dialog window *Print Form Pattern*:

Tap the **OK** button using the stylus.

Assigning a print form template to an application, see beginning at page 5-12.

The print form templates are stored in factory-preset directories. Saving them in other directories is **not** possible!

5.2.2 Editing a print form template

This is carried out in the dialog window *Print Form Pattern*.

Open window ***Print Form Pattern***

1. Call the dialog window ***Print Form Pattern*****:**

Tap **Options / Print Form Pattern...** on the display in succession using the stylus.

Window ***Print Form Pattern***

2. Selecting the print form style:

Tap **Block result**, **Final result** or **Export** using the stylus. Depending on the type of print form associated with the print form template to be changed.

3. Opening the print form template:

Selecting the print form template file

1. Tap the **Open...** button using the stylus.
2. Tap the desired print form template (file).
3. Tap the **Open** button.

The *Open* window closes and the desired print form template appears in the window *Print Form Pattern*. The file name (e.g., Blockres.fet) of the selected print form template file appears under **Filename**.

Editing the print form template

4. Editing the print form template:

☑ = Parameter/characteristic quantity enabled.
☐ = Parameter/characteristic quantity disabled.

Displaying the Parameter/characteristic quantity list: ⊞.

Closing the list: ⊟.

Entries for the parameters "Information" and "Image":

1. Tap the word **Information** or **Image**.
2. Tap the **Properties** button.

Saving changes

5. Saving changes to the print form template:

Tap the **Save** button using the stylus.

6. Closing the dialog window ***Print Form Pattern*****:**

Tap the **OK** button using the stylus.

5.2.3 Assigning the print form template to an application

A print form template for the block result and a print form template for the final result can be assigned to each application. All print form templates are available to all applications. One print form template can be assigned to several applications.

An assignment is carried out for the respective active application from the dialog window *Properties*, Tab *Print Form*.

Open window *Properties*, tab *Print Form*

1. Calling the tab *Print Form* from the dialog window *Properties*:

Tap **File / Properties** in succession using the stylus.

Tap the tab *Print Form*.

2. Assigning print form templates:

Window *Properties*, tab *Print Form*

1. Tap the parameter **User defined**.
2. Tap the ... button using the stylus. The *Open* window appears.
3. Tap the desired file using the stylus.
4. Tap the **Open** button.

   The *Open* window closes. The file name of the selected print form template (e.g., Blockres.fet) appears under the parameter **User defined**.
5. Tap the **OK** button.

   Saving the assignment

   The selected print form templates will be assigned to the application. In the future, the block results or the final results will be displayed and printed according to the assigned print form templates.
   The Properties window closes.

5.2.4 Description of the Display Parameters for the Print Form Template

Fundamentally, a print form template can be put together of the 3 areas header, statistics and footer.

Various display parameters/characteristic quantities are available for all 3 areas:

- Header area, 🗐 5-13.
- Footer area, 🗐 5-13.
- Statistics area for the block evaluation, 🗐 5-14.
- Statistics area for the final evaluation, 🗐 5-15.
- Statistics area for Export, 🗐 5-18.

Header and footer areas:

Fischer Logo
Company logo of Helmut Fischer GmbH.

Device name
FISCHERSCOPE for the FISCHERSCOPE® MMS® PC2 instrument model.

Application name
Designation for the application file (measurement application file), where the evaluated measurement data are stored (example Test.app).

Probe name
Designation of the probe model that is used to make the measurements (example FGAB1.3, FTA3.3).

Date/Time
Date and time of the print form set-up (calling the block result or the final result via the menu **Evaluation/Block Result** or **Evaluation/Final Result**).

Image
Integration of any desired image (e.g., a company logo, sketch of a specimen). 🗐 Procedure see page 5-9.

The screen presentations under **Evaluation/Block Result** and **Evaluation/Final Result** differ slightly from the actual printout.

Information
Text line, e.g., Print form title. 🗐 Entering text see page 5-9.

Statistics area: Display parameters and characteristic quantities for a block result

Date/Time
Date and time of the block closure.

Block Information
Entries (test information) that were assigned to the blocks. These entries can be pre-defined in the menu **Options/Block Info**. Procedure starting at page 5-3.

Readings
Single readings of the block.

Mean value
Mean value of the block.

Standard Deviation
Standard deviation of the single block readings.

Coefficient of Variation
Deviation of the single block readings in percent.

Range
Difference between the lowest and the highest reading of the block.

Minimum value
Lowest measured value within the block.

Maximum value
Highest measured value within the block.

Number of Measurements
Number of measurements per block = Block size.

Number of outlier
Number of measurements that are recognized as outliers according to the integrated outlier monitoring. Relevant only if outlier monitoring has been enabled (**File/Properties**, Tab *Measurement*).

Specification limits
Relevant only if specification limit monitoring has been enabled (**File/Properties**, Tab *Limits*)

Specification limits / Lower Specification Limit (LSL)
Specified lower limit value.

Specification limits / Upper Specification Limit (USL)
Specified upper limit value.

Specification limits / Values lower LSL
Number of measurements within the block that have violated the lower specification limit.

Statistics area: Display parameters and characteristic quantities for a block result

Specification limits / Values upper USL
Number of measurements within the block that have violated the upper specification limit.

Beta
Relevant only for measurements that have been measured using the BETASCOPE® module.

Beta / Density factor
Density factor entered under **File/Properties**, Tab *Beta* or calculated under **Calibration/Density Factor Calculation**.

Beta / Measurement time
Measuring time specified under **File/Properties**, Tab *Beta*.

Statistics area: Display parameters and quantities for the final result

Filter Selection
Filter setting for selecting the measurement data or blocks for the final evaluation (**Evaluation / Block Selection/Output**).

Mean value
Mean value across all single readings, or all blocks, respectively.

Confidence interval
With a certain probability, the assumed "true value" of the measured quantity is within an interval around the mean value.

Standard Deviation
Standard deviation referenced to all single readings or the estimated value of the standard deviation σ of the parent population.

Coefficient of Variation
Deviation of the single readings or of the blocks in percent.

Range
Difference between the lowest and the highest single readings or block mean values.

Minimum value
Lowest measured value or lowest block mean value.

Maximum value
Highest measured value or highest block mean value.

Number of Measurements
Number of all measurements or of all blocks that have been included in the final evaluation.

Statistics area: Display parameters and quantities for the final result

Number of outlier
Number of measurements that are recognized as outliers according to the integrated outlier monitoring. Relevant only if outlier monitoring has been enabled (**File/Properties**, Tab *Measurement*).

Specification limits
Relevant only if specification limit monitoring has been enabled (**File/Properties**, Tab *Limits*).

Specification limits / Lower Specification Limit (LSL)
Specified lower limit value.

Specification limits / Upper Specification Limit (USL)
Specified upper limit value.

Specification limits / Values lower LSL
Number of measurements or block mean values that have violated the lower specification limit.

Specification limits / Values higher USL
Number of measurements or block mean values that have violated the upper specification limit.

SPC Chart
Relevant only if SPC Chart display has been selected (**File/Properties**, Tab *Measurement* and *Limits*).

SPC Chart / Subgroup size
Number of measurements per group (Block).

SPC Chart / Standard deviation sa
Deviation of the block mean values, corrected with regard to the deviation of the single readings. sa is computed only if the deviation of the block mean value according to the variance analysis cannot be explained from the deviation with the blocks.

SPC Chart / Cp
Capability factor for evaluating the process capability.

SPC Chart / Cp k
Capability factor for evaluating the process capability.

SPC Chart / Lower Control Limit (LCL)
Specified value for the lower control limit.

SPC Chart / Upper Control Limit (UCL)
Specified value for the upper control limit.

SPC Chart / LCL(s)
Lower control limit for the s-chart.

SPC Chart / UCL(s)
Upper control limit for the s-chart.

Statistics area: Display parameters and quantities for the final result

SPC Chart / LCL(R)
Lower control limit for the R-chart.

SPC Chart / UCL(R)
Upper control limit for the R-chart.

SPC Chart / Subgroups lower LCL
Number of group mean values that violate the lower control limit.

SPC Chart / Subgoups upper UCL
Number of group mean values that violate the upper control limit.

Beta
Relevant only for measurements made with the BETASCOPE® module.

Beta / Density factor
Density factor entered under **File/Properties**, Tab *Beta* or computed under **Calibration/Density Factor Calculation**.

Beta / Measurement time
Measuring time specified under **File/Properties**, Tab *Beta*.

Beta / F rel
Measurement uncertainty independent of the product taking into account F norm. F rel indicates how reliably the instrument is able to reproduce a mean value based on the performed normalization.

Beta / F total
Total measurement uncertainty. Geometric sum of the measurement uncertainty independent of the product (F rel) and dependent on the product (F Product).

Beta / F norm
Measurement uncertainty of the performed normalization with a specified measuring time and number of measurements.

Beta / F product
Measurement uncertainty dependent on the product. Measurement uncertainty adjusted by the product-independent measurement uncertainty (F rel).

Beta / S product
Product-related standard deviation.

Beta / Sigma (X)
Instrument-related standard deviation. Instrument deviation dependent on the countrate and measuring time. A measure for the deviation of the beta emitter.

Statistics area: Display parameters and quantities for the final result

Beta / Sigma (Xn)
Instrument-related standard deviation. Instrument deviation corresponding to the normalized count rate and the measuring time. A measure for the deviation of the beta emitter.

Beta / Sigma (th)
Instrument-related standard deviation. Instrument deviation dependent on the count rate and the measuring time, converted to the coating thickness measuring unit. A measure for the deviation of the beta emitter.

Graphic
Graphical presentation of measurement data.

Graphic / Histogram
A histogram clearly shows the distribution of the measurement data to the individual classes. For example, how many readings are located in a certain coating thickness range. A minimum of 30 readings is required for the histogram presentation.

Graphic / Probability chart
In this graphical presentation, the frequency of the measurements of the classes is presented in their cumulative percentage rate. Through special scaling, the readings with normal distribution are presented as a straight line. The probability chart makes apparent the percentage of readings that are below (or above) a certain coating thickness. A minimum of 5 readings is required for the cumulative frequency presentation.

Graphic / Probability chart (log)
A cumulative frequency diagram as described above under "Graphic / Probability chart" however, with logarithmic X-axis scaling.

Graphic / FD-Diagram
Manufacturing Diagnostics graph for graphical comparisons of process values such as the coating thickness, for example. This graph presents the comparison of process values with regard to tolerances or relative conformity. A minimum of 3 concluded blocks with a fixed block size is required for the graphical presentation.

Graphic / 3D Diagram
Graphical 3D-presentation of the block mean values across the blocks. A minimum of 3 concluded blocks with a fixed block size is required for the graphical presentation.

Statistics area: Display parameters and quantities for exporting a print form

See description "Statistics area: Display parameters and characteristic quantities for a block result", 🗐 beginning at 5-14.

SPC Chart and **Beta** see description "Statistics area: Display parameters and quantities for the final result", 🗐 beginning at 5-15.

5.3 Setting the Language

Changes to the language are done separately for the measurement program and for the operating system.

- Changing the language setting of the measurement program MMS PC2 (MMS_CE), 5-20.
- Changing the language setting of the operating system (WinCexx), 5-22.
- Selecting the country code for the connected PC keyboard, 5-24.

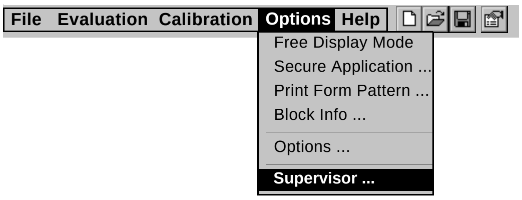
An Asian operating system is required to set up Asian languages. The English language is available in all operating systems.

Calling the language area for the installed operating system:

- Tap **Help / About MMS** ... in succession; the window *About MMS PC* will open.
  The version of the operating system is shown in the left window area, e.g., WBA02. The 3rd letter indicates the language area:
  A: Western (Czech, English, French, German, Italian, Spanish)
  T: Chinese (Taiwan)
  P: Chinese (China)
  J: Japanese

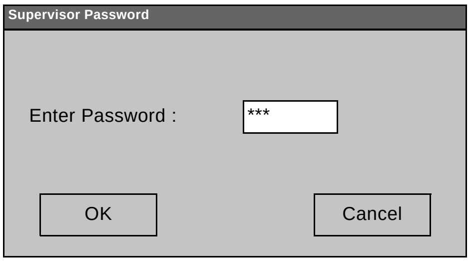
5.3.1 Setting the Language: Measurement and Evaluation Program MMS_CE

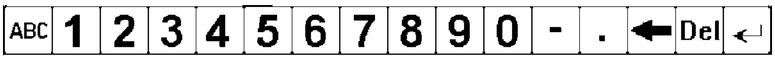
1. Calling the Supervisor menu:



Options / Supervisor ...
Use the stylus to tap these menu commands in successon.

2. Entering the Supervisor code (password):





1. **1 5 9**
Use the stylus to tap the numbers in the entry bar at the bottom of the display in succession.

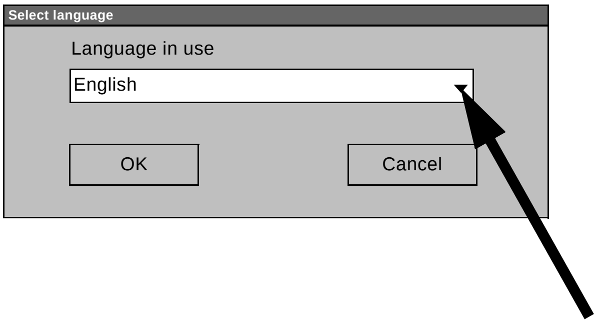
If required, switch the entry bar to numbers: tap **123** at the left control field.

2. Tap the **OK** button with the stylus to open the *Supervisor* window.

3. Selecting the language:

1. Use the stylus to tap the *System* tab from the *Supervisor* window.

2. In the *System* tab, tap the **Language** button with the stylus.



3. Tap ▼
in the window *Language selection* with the stylus (see Figure to the left); then use the stylus to select the desired language (color highlight) from the list that opens.

4. **OK**
Tap this button in the window *Language selection* with the stylus.

A message appears indicating that the new language will be effective only after restarting the MMS_CE program.

5. **OK**
Tap this button in the window *MMS PC* using the stylus.

4. Exiting/closing the Supervisor menu:

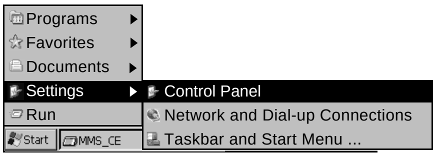
OK
Tap this key in the *Supervisor* window using the stylus.

5. Exiting the MMS_CE Program:

Press the **ON/OFF** key twice to switch the instrument Off and then On again.

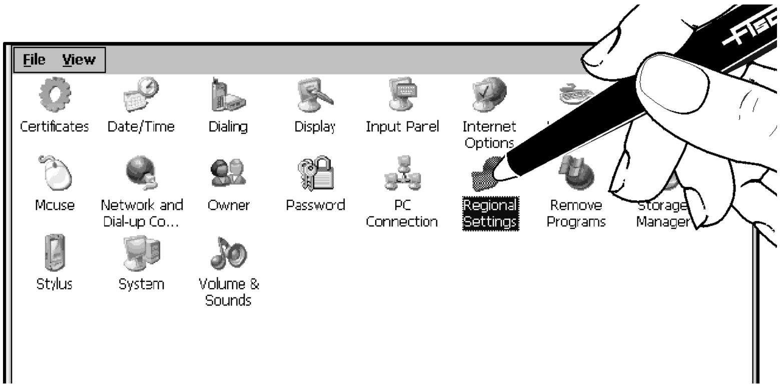
5.3.2 Setting the Language: Operating System (WinCe)

1. Calling the Control Panel:



Use the stylus and tap **Start / Settings / Control Panel** in succession.

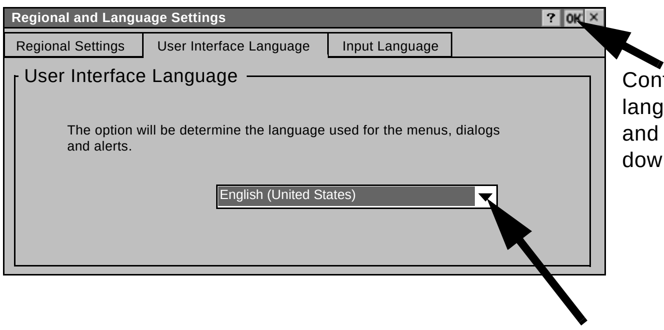
2. Open the window *Regional Settings*:



1. Tap **Regional Settings**, Double-tap the icon:

 .

3. Selecting the language:



Confirm changed language setting and close window.

1. Tap ▼ in the window *Regional and Language Settings* (see figure to the left); then use the stylus to select the desired language (color highlight) from the list that opens.

Perform the language selection for the tab *User Interface Language* as well as for tab *Input Language*.

2. Tap **OK** in the window title bar.

A message appears indicating that the new language will be effective only after restarting the operating system.

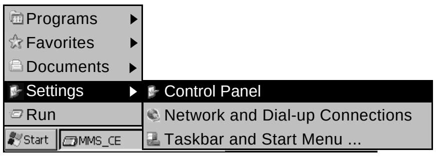
3. Tap **OK** in the title bar of the window.

4. To accept the current settings:

Press the **ON/OFF** key twice to switch the instrument Off and then On again.

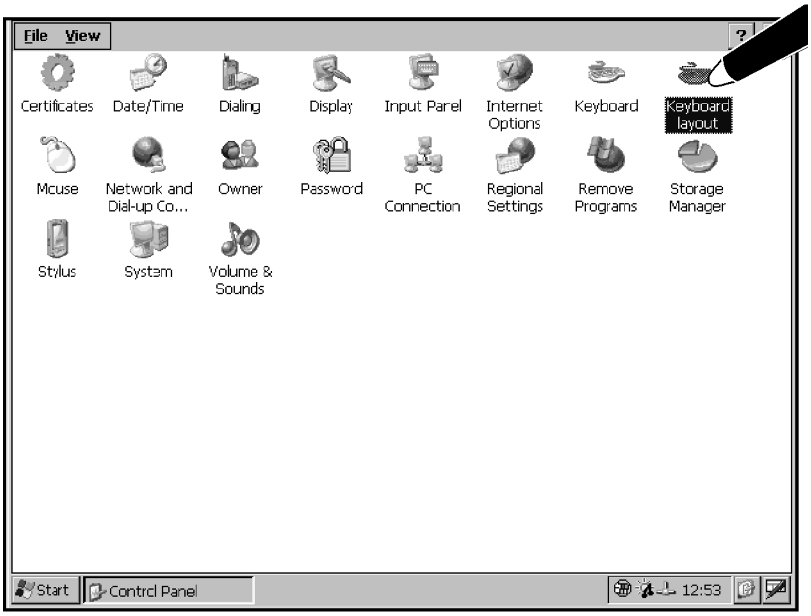
5.3.3 Setting the Keyboard Layout: for the Connected PC Keyboard

1. Calling the Control Panel:



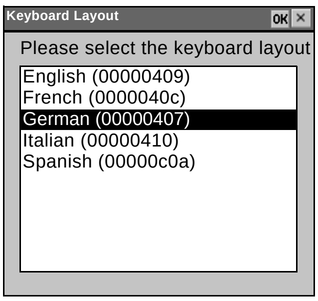
Use the stylus and tap **Start / Settings / Control Panel** in succession.

2. Open the window *Keyboard Layout***:**



1. **Keyboard Layout**
tap this icon in the window *Control Panel (Systemsteuerung)*, double tap the icon: .

3. Select the keyboard layout:



1. Tap in the window *Keyboard Layout* the desired country with the stylus (color highlight).

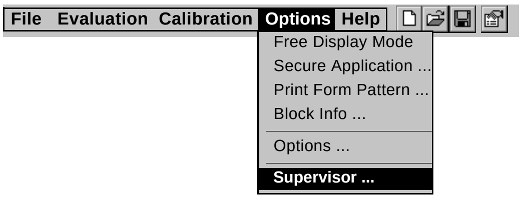
2. **OK**
tap this button in the title bar of the window *Keyboard Layout*.

4. To accept the current settings:

Press the **ON/OFF** key twice to switch the instrument OFF and then On again.

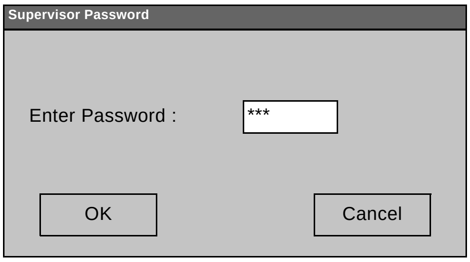
5.4 Setting the Measurement Unit

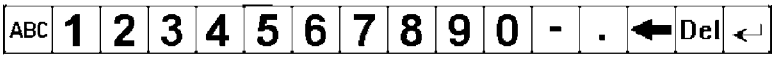
1. Calling the Supervisor menu:



Options / Supervisor ...
Use the stylus to tap these menu commands in successon.

2. Entering the Supervisor code (password):



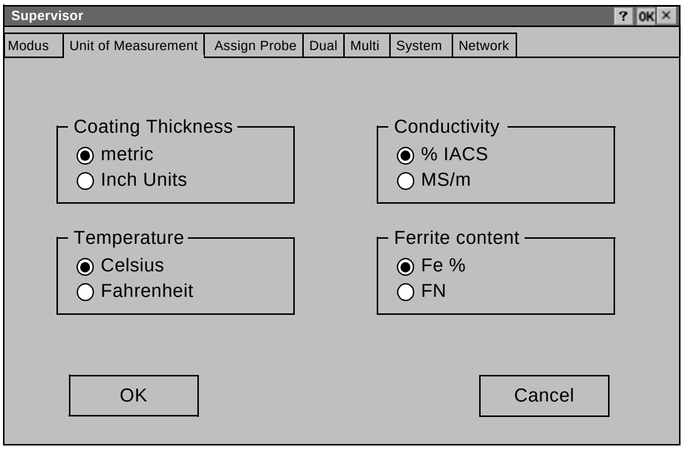


1. **1 5 9**
Use the stylus to tap the numbers in the entry bar at the bottom of the display in succession.

If required, switch the entry bar to numbers: tap **123** at the left control field.

2. Tap the **OK** button with the stylus to open the *Supervisor* window.

3. Selecting the measurement unit:



1. Use the stylus to tap the *Unit of Mesaurement* tab from the *Supervisor* window.

2. Select the desired units with the stylus.

All units which can be measured with the instrument are displayed in the *Unit of Mesaurement* tab.

3. **OK**
Tap this button in the window *Supervisor*, tab *Unit of Mesaurement* with the stylus.

4. Exiting/closing the Supervisor menu:

OK, Tap this key in the *Supervisor* window using the stylus. After leaving the Supervisor menu all readings are displayed in the unit set in the tab *Unit of Mesaurement.*

5.5 Calibration of the Touch Screen

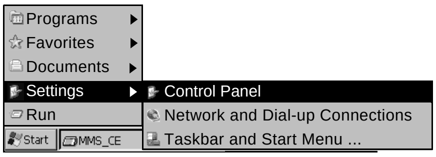
The following cases require a calibration of the touchscreen:

- The touch screen does not respond properly to your tap.
- Another operation as you tapped with your stylus is performed.

Procedure

1. Calling the Control Panel:

Use the stylus and tap **Start / Settings / Control Panel** in succession.



Calling the calibration program

2. Calling the calibration program:

double-tap the icon  using the stylus.

Window *Stylus Properties*

3. Calibration of the touch screen

1. Tap the tab *Calibration*.

Start calibration

2. Start calibration: tap the **Recalibrate** button using the stylus.
3. Follow the instructions on the screen.

Save calibration

4. Save the calibration: press the **ENTER** key below the Display.

   The window *Stylus Properties* appears.

4. Setting the speed for the double-tap:

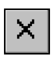
(if not required continue with step **5.**)

1. Tap the tab *Double-Tap*.
2. Follow the instructions in the window.

Close the calibration program

5. Quit the calibration program:

Tap **OK** in the title bar of the window *Stylus Properties*.

6. Close the Control Panel: Tap  on the window title bar.

6 Communication with the FISCHERSCOPE® MMS® PC2

The measuring instrument offers various connections for data transfer, data control, data export and data storage.

Devices/networks etc. that can be connected	Connection to the MMS® PC2	Description beginning on Page
Printer USB Memory stick External hard drive PC keyboard PC mouse	USB (one of the 4 USB connections)	6-3
PC	USB (PC)	6-9
PC	COM1	6-16
Ethernet network	LAN connection	6-29

6.1 Connections USB

Connecting a printer, a USB memory stick, an external hard drive, a hub, a PC keyboard, a PC mouse.

4 ports, 2.0 compatible.
Max. cable length for connection: 5 m
The frame around the upper left USB port indicates the High Power USB port for devices that have a greater power consumption such as an external hard drive without its own power supply, for example;
High Power USB port: max. 500 mA supply current
Standard USB port: max. 100 mA supply current

6.1.1 Printing via USB Port

We recommend using the printer drivers supplied in the instrument!
They are specifically adapted for the operating system of the measuring instrument.

Connect the printer and turn it on.

1. Connect to printer to one of the USB ports and turn it on.

Call the print menu (window *Printer*)

2. For printing, call up the print menu: Tap **File / Print...** in succession with the stylus.

Settings in the window *Printer*

3. Window *Print*:

   One-line selection window "Printer:": Select the printer driver according to the selection table below.

   One-line selection window "Connection:": Tap USB1.

Start printing: OK

4. Start printout: Tap the **OK** button in the upper right corner of the *Printer* window with the stylus.

Printer selection table

*Printer driver to be selected (under "Printer:")	Printing method and printer types
EPSON InkJet	all EPSON inkjet printers
ESCP	all EPSON and other printers with ESC/P printer language emulation
generic Stylus C	EPSON printers of the "Stylus C" series
generic Stylus Color	EPSON printers of the "Stylus Color" series
generic Stylus Photo	EPSON printers of the "Stylus Photo" series
generic Stylus Photo R	EPSON printers of the "Stylus Photo R" series
PCL Inkjet	all inkjet printers from HP and other manufacturers with a PCL printer language emulation.
PCL Laser	all laser printers with a PCL printer language emulation.
Kyosha Kyoline	Thermal printers from Kyosha, Printer FPT 100, sold by Fischer as a purchased device.

* Due to the numerous printers available on the market, Helmut Fischer GmbH cannot ensure that the listed printer drivers will always be suitable. Please contact Helmut Fischer GmbH or their representative in your country if you cannot select a suitable printer driver for your connected printer. www.helmut-fischer.com

6.1.2 USB Memory Sticks

The following brands of USB memory sticks can be used:
Intuix 32 MB Memory Key
Captiva 256 MB USB Bar

Essentially, all USB sticks that are based on the “DiskOnKey” technology of the M-System company should work.

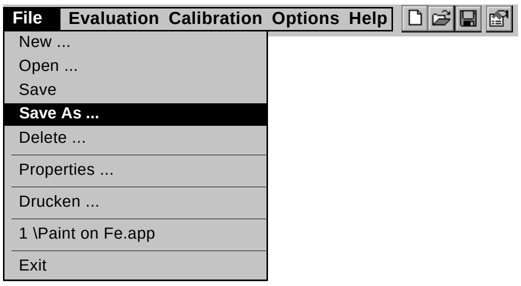
It may take up to 1 minute until the operating system of the measuring instrument recognizes the USB stick. The directory **Mounted Volume** will then be set up automatically under **My Computer**.

6.1.3 Saving Applications/Files to an External Data Carrier, e.g., an USB stick

The procedure for saving is shown using a sample of saving any Application on an USB stick.

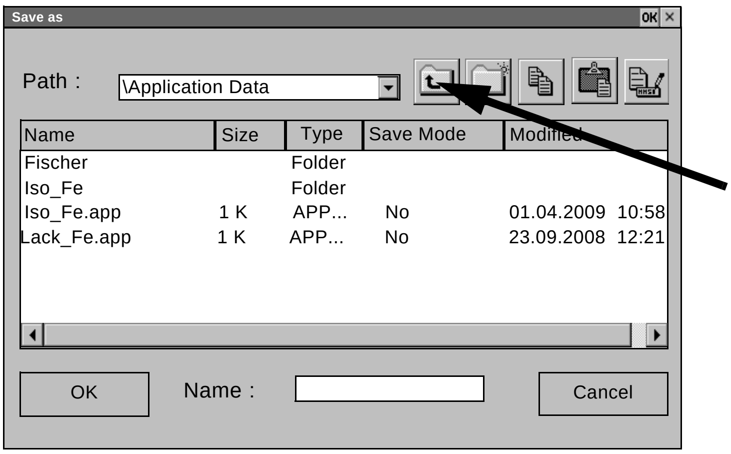
Procedure

1. Opening the window *Save As...* **:**

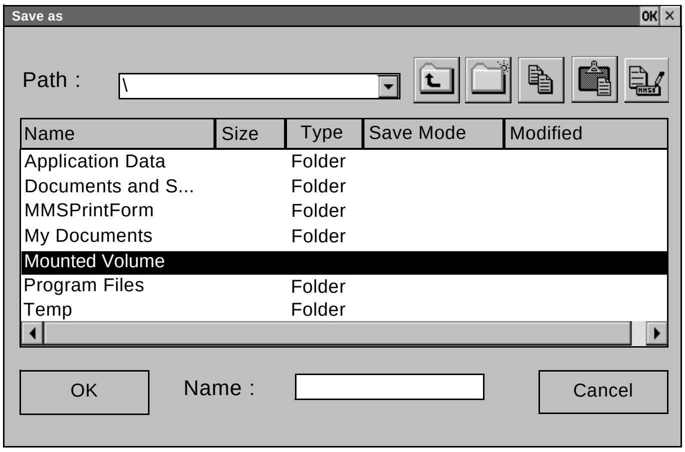


Tap **File / Save As ...** in succession with the stylus on the display.

2. Select USB stick:



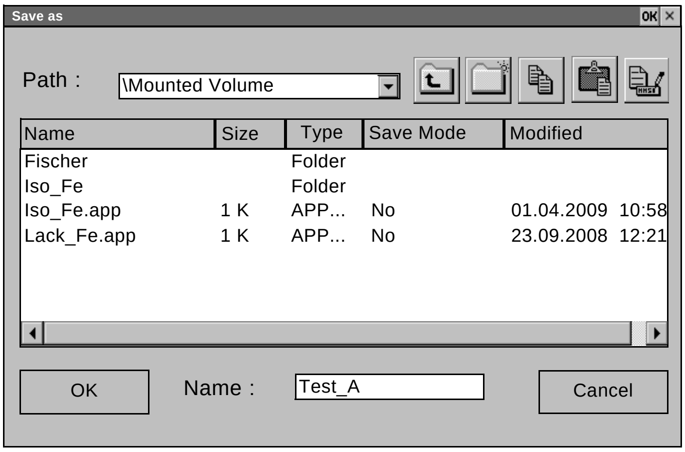
1. Exit the current directory:
Tap  .

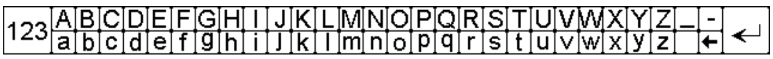


2. Double-tap the directory **Mounted Volume**.

3. If necessary, double-tap the desired directory **on the USB-Stick**.

3. Assigning Application Names:

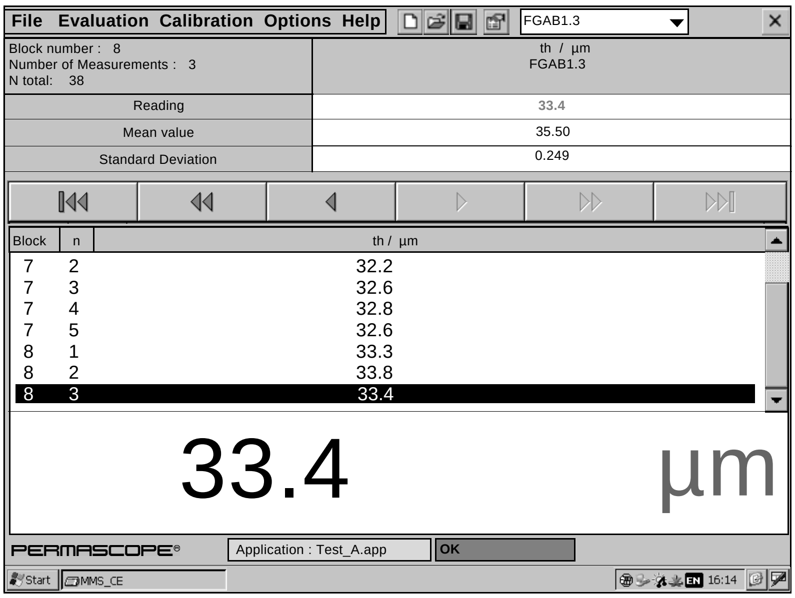




1. **Test_A** (example name) Use the stylus to tap in the “Name:” field. Use the stylus to tap the letters in succession in the character bar at the lower display edge.

If necessary, toggle the character bar to numbers or letters: Tap the 123 or ABC button on the left.

2. Saving the file to the USB stick: Tap the **OK** button.



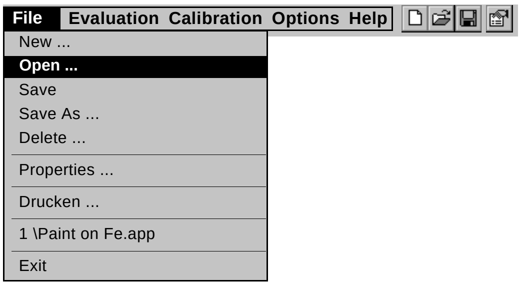
The displayed Application is now saved on the USB stick and can be opened from there.
6-7.

6.1.4 Calling/opening Applications/Files from External Data Carriers, e.g., USB Stick

Opening is demonstrated using a sample Application stored on a USB stick.

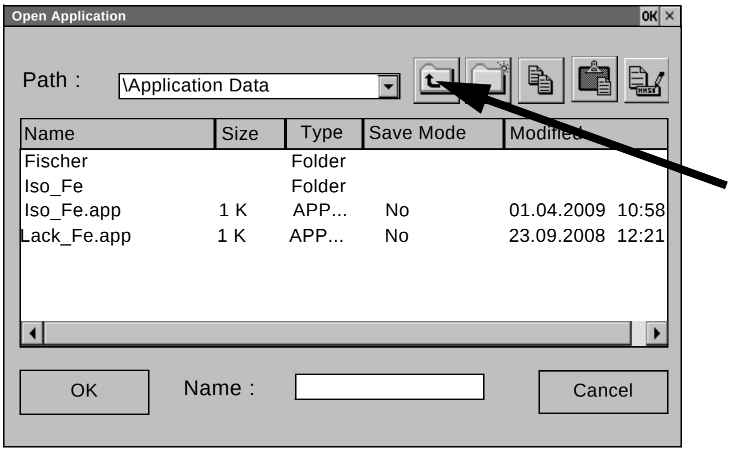
Procedure

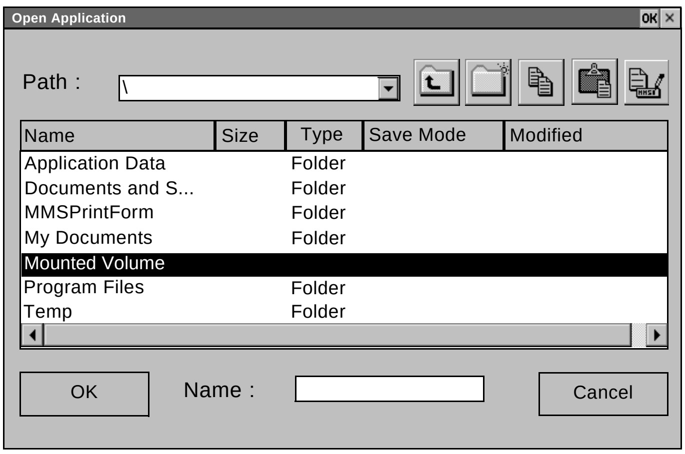
1. Calling the window ***Open Application*****:**



Tap **File / Open ...** in succession with the stylus on the display.

2. Select USB stick:





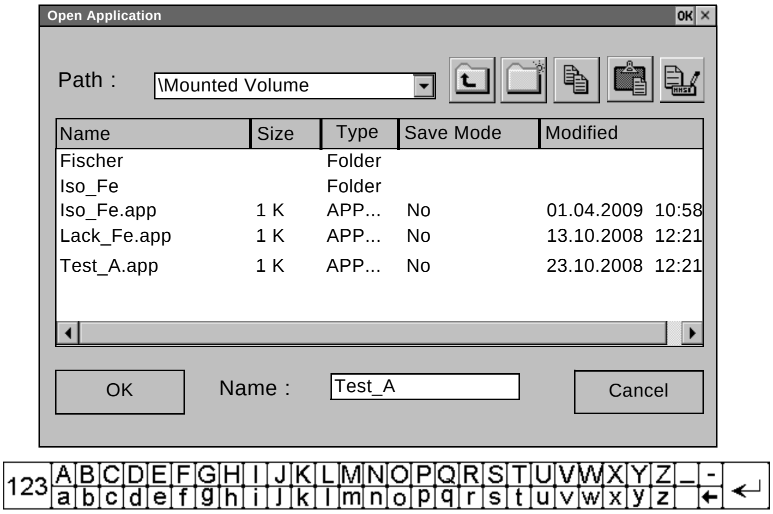
1. Exit the current directory: Tap  .

Data carriers (USB stick) are displayed as “Mounted Volume”.

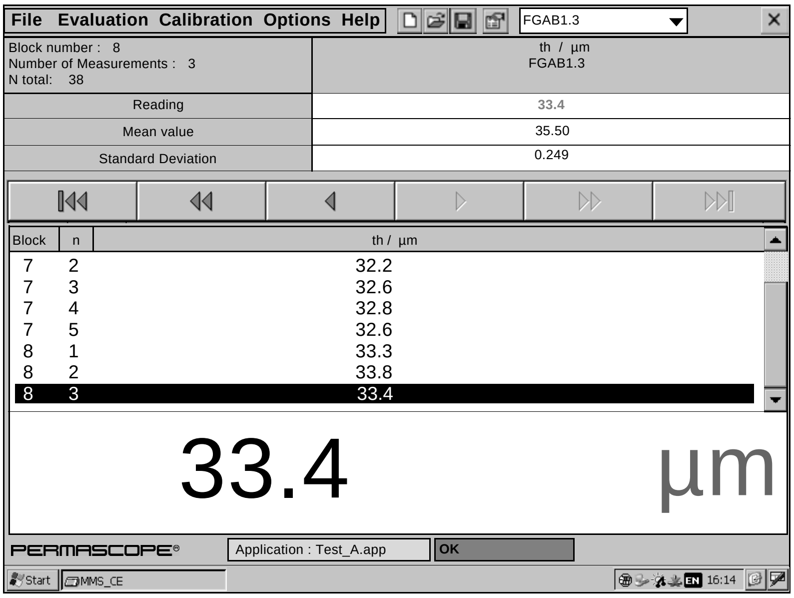
2. Double-tap the directory **Mounted Volume**.

3. If necessary, double-tap the desired directory **on the USB-Stick**.

3. Select the desired Application:



1. **Test_A.app** (example name)
   Double-tap the file name.



The desired Application opens.

Tapping saves the changes (e.g., new measurement data) directly to the USB stick under the displayed Application name.

6.2 Connection USB (PC)

The USB interface (PC) is intended for connecting a PC and can be operated using the following two methods:

Operating modes of the USB interface (PC)	Page
Active Sync (external drive) Using the Windows **ActiveSync** program, the MMS® PC2 cab be used like an external drive. Data can be copied or moved from the PC to the MMS® PC2 or vice versa via "Windows Explorer".	6-15
To operate the MMS® PC2 using Active Sync at the PC, a respective USB driver for Active Sync and the ActiveSync communication program must be installed on the PC.	6-13
Virtual COM Port (serial interface) The USB interface (PC) can also be operated as a serial interface, designated as **Virtual COM Port**, similar to the COM1 interface. The following functions are available: ● Transfer of the readings and the characteristic statistical data from the instrument to the PC. ● Remote control of the instrument by sending commands from the PC to the instrument. ● Requesting measurement data and other data (e.g., the name of the current Application) by sending commands from the PC to the instrument. ● Transfer of data (e.g., designations for Applications) from the PC to the instrument by sending commands from the PC to the instrument. The USB port (PC) as the serial interface cannot be operated at the same time as the COM1 port.	6-12
To operate this USB port as a serial interface, a respective USB driver for the measuring instrument must be installed in the PC.	6-10

Program or driver installations for Active Sync and the serial interface can both reside in the PC at the same time. The operating mode toggle is carried out in the instrument under **Tools/Options**, tab *COM Parameters*, frame *"*USB (PC)*"*.

Both commercial or one's own data processing programs can be used to process the data exported by the instrument. Information regarding import and processing of the data using such programs may be obtained from the respective manuals for these programs.

Basic computer knowledge regarding configuration, operation and programing as well as knowledge of the software in use, which may be obtained from respective instruction manuals, is required when using the instrument in conjunction with a computer.

Connection USB (PC):
USB 2.0 compatible, USB connection with Function feature.

6.2.1 USB Connection to the PC

Connect the USB port of the instrument (USB (PC)) to the USB port of the PC. Use the USB cable supplied with the instrument.

If the USB port (PC) for the communication with the PC is to be operated as a serial interface, the respective USB driver for the measuring instrument must be installed on your PC (USB driver (Virtual COM Port) on USB driver CD included with the instrument).

If the MMS® PC2 is to be used as an external drive, the respective USB driver and the ActiveSync communication program must be installed on your PC (both included on the USB driver CD. However, it is also possible to download the program from the Microsoft® homepage).

6.2.2 Installations/Settings for Using the USB Port (PC) as a Serial Interface (Virtual COM Port)

Installing the USB river (Virtual COM Port) on the PC

The USB driver for a virtual COM port must be installed on the PC if the (PC) connection of the MMS® PC2 shall be used as serial data interface. This USB driver is located on the USB driver CD that is supplied with the instrument; however, it can also be downloaded from our Internet presence www.helmut-fischer.com. Below is a description of the installation on a PC with the Windows® XP operating system.

The USB driver was downloaded from the Helmut Fischer GmbH Internet presence:
Before installing the driver, unpack the downloaded driver file into a directory on your PC (e.g., C:\Programe\USB-Treiber\MMSPC2_USB).
www.helmut-fischer.com

Procedure

1. Set the instrument to serial interface

1. Use the stylus to tap **Options / Options** in succession.
2. Tap the tab *COM Parameter*. — **Window** *Options*
3. Set the desired mode (operating mode) under USB (PC): Select the parameter “**Virtual Com Port**”.
4. Tap the **OK** button. — **Save the setting and exit the** *Options* **window**

5. Turn off the instrument: **ON/OFF** key on the front of the unit.

2. Connect the instrument to the USB port of your PC and turn it on.

The "Found New Hardware Wizard" opens.

3. Follow the instructions of the Windows wizard.

If the driver is not found automatically, select or enter if necessary the source to search for the USB driver (e.g., CD-ROM drive, removable media (CD, diskettes, ...) or local path (C:\Programe\USB-Treiber\MMSPC2_USB).

Windows® XP:
Ignore the message for the Windows Logo Test (Window “Hardware Installation”). Click the **Continue Installation** button and continue the installation.

Windows® Vista:
Installing the driver software requires confirmation in user account control (Window "User account control"). Click the **Continue** button to carry out the installation.
Ignore the message about the manufacturer check for the driver software (Window "Windows Security"): Click "Install this driver software anyway" and continue the installation.

The successful installation of the USB driver can be verified in the Windows Device Manager.

1. Open the Device Manager: **Start/Control Panel/System**, *Hardware* tab, **Device Manager** button.

2. You will find an additional COM port under "Ports (COM & LPT)", e.g., USB Driver for Fischer virtual COM port (COM5) if the instrument is connected to your PC via the USB (PC) interface.

The successful connection between the PC and the FISCHERSCOPE® MMS® PC2 instrument is indicated on the display through the symbol  above the task bar.

The MMS® PC2 should always be connected to the same USB port.
The USB driver is installed only for the USB connection to the PC to which the instrument was connected during the driver installation!

If problems occur with the USB connection, connect the instrument to a USB port at the rear of the PC and re-install the USB driver. The connections to the USB interface on the front of the PC can be unstable occasionally.

Data transfer is now carried out via the virtual COM port. The virtual COM port behaves in the same manner as the COM1 port of the instrument. To see which data can be transferred in which manner, please see the respective Chapters beginning on Page 6-20.

Data Transfer Settings

Prerequisites

- The USB driver (Virtual COM Port) is installed on the PC - as described in the previous section.
- Instrument and PC are connected to each other and switched on.

Procedure

1. Activating the USB (PC) as a serial interface

Settings in the FISCHERSCOPE® MMS® PC2:

Window *Options*, tab *COM Parameters*
Frame "USB (PC)"

1. Use the stylus to tap **Options / Options** in succession.
2. Tap the tab *COM Parameter* from the *Options* window.
3. Under USB (PC) select the "**Virtual COM Port**" mode

> **The mode settings for COM1: "Online Data" *and* USB (PC): "Virtual COM Port" are not permitted at the same time.**
> The instrument can only supply one of the two serial interfaces with data! Set another mode for the port that is not in use (e.g., “Off”).

2. Saving the settings:

Saving the settings

Tap the **OK** button.

The *Options* window closes.

6.2.3 Installations for Using ActiveSync on the PC

If the instrument is to be accessible from the PC as an external drive, both the respective USB driver (ActiveSync) and the ActiveSync software need to be installed on the PC. Both are supplied on the USB driver CD that is shipped with the instrument. Below is a description of the installation on a PC with the Windows® XP operating system.

Procedure

1. Set the measuring instrument to ActiveSync operation

Settings in the MMS® PC2

1. Use the stylus to tap **Ooptions / Options** in succession.
2. Tap the tab *COM Parameter*. — Window *Options*
3. Set the desired mode (operating mode) under USB (PC): Select the parameter "**Active Sync**".
4. Tap the **OK** button. — Save the setting and exit the *Options* window
5. Turn off the instrument: **ON/OFF** key on the front of the unit.

2. Installing the USB driver for ActiveSync operation on the PC

Installation on the PC

1. Connect the instrument (USB port (PC)) to the USB port of your PC.
2. Turn on the instrument: **ON/OFF** key on the front of the unit.

   The "Found New Hardware Wizard" opens.
3. Follow the instructions of the Windows wizard.

   If the driver is not found automatically, select or enter if necessary the source to search for the USB driver (e.g., CD-ROM drive, removable media (CD, diskettes, ...) or local path). (C:\Programe\USB-Treiber\MMSPC2_USB).

Windows® XP:
Ignore the message for the Windows Logo Test (Window "Hardware Installation"). Click the **Continue Installation** button and continue the installation.

Windows® Vista:
Installing the driver software requires confirmation in user account control (Window "User account control"). Click the **Continue** button to carry out the installation.
Ignore the message about the manufacturer check for the driver software (Window "Windows Security"): Click "Install this driver software anyway" and continue the installation.

Installation on the PC

3. Installing the ActiveSync program on the PC

1. Call the Windows software installation: **Start/Control Panel/Software**
2. Click the **Add new programs** button.
3. Follow the instructions of the installation routine.
   If the program is not found start automatically, select the msi file from the CD in the directory "...\Async\" (e.g., Async_4_5_ENU.msi).

Windows® XP:
Ignore the message for the Windows Logo Test (Window "Hardware Installation"). Click the **Continue Installation** button and continue the installation.

Windows® Vista:
Installing the driver software requires confirmation in user account control (Window "User account control". Click the **Continue** button to carry out the installation.
Ignore the message about the manufacturer check for the driver software (Window "Windows Security"): Click "Install this driver software anyway" and continue the installation.

When the installation is complete, the window *New Partnership* of the ActiveSync program will open.

PC: Window *New Partnership*

4. Select “No” in the window and click the **Continue** button. The *Microsoft Active Sync* window will appear.

Window *Microsoft Active Sync*

5. Close the window: Click the **X** button in the top right corner of the window.

The successful connection between the PC and the FISCHERSCOPE® MMS® PC2 instrument is indicated by the respective symbol in the task bar on the PC monitor or directly above the task bar on the instrument display.

The MMS® PC2 should always be connected to the same USB port.
The USB driver is installed only for the USB connection to the PC to which the instrument was connected during the driver installation!

If problems occur with the USB connection, connect the instrument to a USB port at the rear of the PC and re-install the USB driver. The connections to the USB interface on the front of the PC can be unstable occasionally.

Now, files can be copied and moved from the PC to the instrument and vice versa. The description can be found beginning on Page 6-15.

6.2.4 Copy, Move, Delete Files from/to the MMS® PC2

Prerequisites

- USB driver and ActiveSync program are installed on the PC, 6-13.

Procedure

1. Set the measuring instrument to ActiveSync operation — **Settings in the MMS® PC2**

1. Use the stylus to tap **Options / Options** in succession.
2. Tap the tab *COM Parameter*. — Window *Options*
3. Under USB (PC), select the "**Active Sync.**" mode.
4. Tap the **OK** button. — Save the setting and exit the *Options* window

2. Establishing the USB connection to the PC — **USB connection MMS® PC2 - PC**

Connect the instrument (USB port (PC)) to the USB port of the PC (USB cable is supplied with the instrument). The window *New Partnership* opens in the PC Monitor.

5. Select “No” in the window and click the **Continue** button. The *Microsoft Active Sync* window will appear. — **PC:** Window *New Partnership*
6. Close the window: Click the **X** button in the top right corner of the window. — **PC:** Window *Microsoft Active Sync*

3. PC: Open Windows® Explorer — **PC: Windows Explorer**

The instrument appears as a new drive under "Mobile Device" in the "My Computer" directory.

4. Copying, moving, deleting files

1. From the PC, files can now be copied and moved to the drive "Mobile Device" (= MMS® PC2 instrument) as usual using Windows® Explorer or can be copied, moved or deleted from the drive.

6.3 Connection COM 1

As a standard, the rear of the FISCHERSCOPE® MMS® PC2 instrument features an RS232-interface, designated with COM1.

Bi-directional data exchange occurs via the RS-232 interface. The following operations are possible if the RS-232 interface of the MMS® PC2 is connected to a computer (PC):

- Transfer of the readings and the characteristic statistical data from the instrument to the PC.
- Remote control of the instrument by sending commands from the PC to the instrument.
- Requesting measurement data and other data (e.g., the number of the current Application) by sending commands from the PC to the instrument.

Both commercial or one's own data processing programs can be used to process the data exported by the instrument. Information regarding import and processing of the data using such programs may be obtained from the respective manuals for these programs.

6.3.1 Establishing the connection to the PC

Basic computer knowledge regarding configuration, operation and programing as well as knowledge of the software in use, which may be obtained from respective instruction manuals, is required when using the instrument in conjunction with a computer.

- Connect the “COM1” port of the instrument to the serial interface (RS232, COM...) at the PC. Use our interface connection set ActiveSync. Pin-out of the COM1 connection, 1-5.

6.3.2 Data Transfer Settings

Prerequisites

- Instrument and PC are connected to each other and switched on.

Procedure

Settings in the FISCHERSCOPE® MMS® PC2:

1. Activating the COM1 Interface

Activating the COM1 Interface at the instrument

1. Use the stylus to tap **Options / Options** in succession.
2. Tap the tab *COM Parameter* from the *Options* window.
3. Under COM1, select the "**Online Data**" mode.

   Now the data transfer parameters can be set.

The mode settings for COM1: "Online Data" ***and*** **USB (PC): "Virtual COM Port" are not permitted at the same time.**
The instrument can only supply one of the two serial interfaces with data! Set another mode for the port that is not in use (e.g., "Off").

2. Configuring the data transfer parameters

Window *Options*, tab *COM Parameters*
Frame "COM1"

Configure the desired data transfer format. The same interface parameters must be configured for both the PC and the MMS® PC2. Description of the data transfer parameters 6-18.

The configuration of the data transfer formats is an instrument settings an applies to all Applications.

3. Saving the settings:

Saving the settings

Tap the **OK** button.

The *Options* window closes.

Which data should be transferred can be set from the *Options* window, tab *COM Output*, see Page 6-20.

Data Transfer Parameters

The data transfer parameters (= interface parameters) of the MMS® PC2 and of the connected device (e.g., PC) must correlate. Otherwise, proper data transfer will not be possible!

Mode	Using the interface output (none, online data transfer, e.g., to a PC or a printer, connection of a support stand or a programmable XY measuring stage) **Factory setting**: Online output
Baud rate	Data transfer rate. Since data are transferred via a serial port, the transfer rate is calculated in bits per second. **Factory default setting**: 9600
Handshake	Type of data transfer acknowledgement. One device transmits a signal to the other if data transfer is possible. **Factory default setting**: none
Stop bits	With serial asynchronous data transfer, the stop bit is added to the data word to be transferred. 1 to 2 bit logic Ones are used. After the stop bits, the sender remains at logic One until the start bit of the next character arrives. **Factory default setting**: 1
Parity	An error check method, where the cross-sum of all error-free transmitted bit groups must always be even or odd. The type of parity requirement must be defined prior to data transfer. **Factory default setting**: none
Data length	Number of bits to be used to present an ASCII character. **Factory default setting**: 8

6.4 Data transfer via COM1 or Virtual COM Port

Two equal serial interfaces are available at the MMS® PC2 - COM1 and USB (PC) in the "virtual COM Port" mode. Bi-directional data exchange occurs via the serial interface. The following functions are enabled when one of the serial interfaces of the MMS® PC2 is connected to a computer (PC):

- Transfer of the readings and the characteristic statistical data from the instrument to the PC.
- Remote control of the instrument by transmitting commands from the PC to the instrument.
- Requesting measurement data and other data (e.g., the number of the current Application) by transmitting commands from the PC to the instrument.

Both commercial or one's own data processing programs can be used to process the data exported by the instrument. Information regarding import and processing of the data using such programs may be obtained from the respective manuals for these programs.

6.4.1 The Path to Data Transfer

... via the COM1 port		**... via USB (PC) in the "Virtual COM Port" mode**	
Connect the instrument to the PC	🗐 6-16	Connect the instrument to the PC	🗐 6-10
Data Transfer Settings	🗐 6-17	Activate the Virtual COM Port interface	🗐 6-10
Select data output	🗐 6-20	Select data output	🗐 6-20

- Data transfer from the MMS® PC2 to the PC

  Data transfer during the measurement: 🗐 6-23

  Later data transfer: 🗐 6-23

- Controlling the MMS® PC2 from the PC: 🗐 6-24

6.4.2 Selecting the Data to Be Transferred

Defining the data to be transferred via the serial data interface, e.g., single readings, block statistics, standard deviation and others.

Procedure

1. Setting the data transfer method:

Settings in the FISCHERSCOPE® MMS® PC2:

Window *Options*, tab *COM Output*

1. Use the stylus to tap **Options / Options** in succession.
2. Tap the tab *COM Output* from the *Options* window.
3. Select the desired parameters. Select the data to be output to the serial data interface (COM1 or USB (PC) Virtual COM Port). Parameter description 6-21.

2. Saving the settings:

Saving the settings

Tap the **OK** button.

The *Options* window closes.

Data output to the serial data interface COM1 or virt. COM Port

Output if measurement

Date/Time	Date and the time of the captured reading.
Application name	Name of the application file.
Blocknumber	Number of the block which contains the printed single reading.
Single readings	When the measurement is taken, every reading appears on the display and at the same time is output to the serial data interface.

Status of measurements

Output if the single reading is below, between or above the set specification limits. Output only when specification limits are enabled.
The instrument send to the PC an 8 bit string followed by CR and LF. The 8 bit of the string represent the 8 slots of the instrument.
One bit can have following status:
0 - output not selected, limit monitoring disabled
1 - Measurement within the specification limits
2 - Measurement above the upper specification limit
3 - Measurement below the lower specification limit

Examples:
00000011 : Measurements of slot 1 and 2 are within the limits
00000033 : Measurements of slot 1 and 2 are below the lower limit
00000022 : Measurements of slot 1 and 2 are above the upper limit
00000013 : Measurement of slot 1 is below the lower limit and measurement of slot 2 is within the limits
00000031 : Measurement of slot 1 is within limits and measurement of slot 2 is below the lower limit
00000012 : Measurement of slot 1 is above the upper limit and measurement of slot 2 is within limits
00000021 : Measurement of slot 1 is within limits and measurement of slot 2 is above the upper limit
00000032 : Measurement of slot 1 is above the upper limit and measurement of slot 2 is below the lower limit
00000023 : Measurement of slot 1 is below the lower limit and measurement of slot 2 is above the upper limit

Mean value of i individual values

The averaged measured value (= displayed value) is output only when the function “i individual value” (i > 1) is enabled.

The individual readings that are used to form the mean value can be transferred to the PC only while the measurement is in progress, because these individual readings are not stored. To do this, enable the parameter "Individual values".

Separator

The set group separator is output to the serial port with every single reading.
Selectable separator characters: CRLF | LF | CR | , | * | ; | # | :

Output if Block Result

Date/Time	If automatic block creation is enabled, the date and the time of the block shown on the display is output to the serial port with every close of a block.
Application name	Name of the application file.
Blocknumber	Number of the printed block.
Mean value	If automatic block creation is enabled, the block mean value of the block shown on the display is output to the serial port with every close of a block.
Standard Deviation	If automatic block creation is enabled, the standard deviation of the block shown on the display is output to the serial port with every close of a block.
Mean value of i individual values	The averaged measured value (= displayed value) is output only when the function “i individual value” (i > 1) is enabled. The individual readings that are used to form the mean value can be transferred to the PC only while the measurement is in progress, because these individual readings are not stored. To do this, enable the parameter “Individual values”.
Complete Block Result Print Form	Output of text including data (readings, statistical evaluation) according to the active printform template. Documentation 5-7.
Values of Block Result Print Form only	Output of the data only (readings, statistical evaluation) according to the active printform template. Documentation 5-7.
Group separator	If automatic block creation is enabled, the set group separator is output to the serial port with every close of a block. Selectable group separator characters: ASCII 29 (GS) | , | * | ; | # | :

6.4.3 Transmitting Data to the PC During the Measurement

Procedure

1. Connect the instrument to the PC. Power up both devices.
2. Start the measurement.
   Depending on the data export settings in the tab *COM Output* (Menu **Options/Options**), no, all measurements and/or the block mean value, etc. are transmitted directly to the connected and operational PC during the measurement.

6.4.4 Transmitting Data to the PC After the Measurement

The readings and statistical evaluations of an Application can be transmitted any time after the measurement from the instrument to a PC. The data are transmitted according to the settings in the tab *COM Output* (Menu **Options/Options**).

Procedure

1. **Calling desired Application.**
2. Tap **Evaluation / Final Result** in succession with the stylus on the display.

   Window *Block selection*

3. Select the desired measurement data blocks: Select the first desired block (tap with stylus) from the right list and accept the block number by tapping the upper double-arrow button. Perform the same steps for the last block for which the data are to be transmitted to the PC. Accept the block number by tapping the lower double-arrow button.

   Selecting the desired measurement data

4. Transmitting data: Tap the **Export** button; the window *Export data to file or com port* opens.

   Tap the **COM** button.

   Transmitting data: Export and COM button

6.4.5 Transmission from the PC to the Instrument, Bidirectional Data Exchange

Transfer Formats

- All input and output data are transferred as ASCII-Strings followed by CRLF (Carriage Return Line Feed; CR = ASCII13, LF = ASCII10).
- The commands must end with a CR (ASCII13), LF (ASCII10) or CRLF.
- The max. length of data received by the instrument is 20 characters.

Control Commands

The instrument can be remote controlled and can request readings and other data by transmitting the control commands from the PC to the instrument. The requested readings or the data, respectively, are then transmitted by the instrument via the serial data interface and received by the PC.

Control Commands

Command to MMS® PC2	Description
CAL	Calls the corrective calibration function (Menu **Calibration/Corrective Calibration ...**).
CALM	Calls the master calibration function (Menu **Calibration/Master Calibration...** . Can be called up only with the setting “Expanded Menu” on the display.).
DAT0 ... DAT19999	Requests the date and time of the block closure of the required block (0 ... 19999). Example: The command “DAT2” outputs the date and time of the block closure of the third block of the current Application (measurement application memory/file). Output example.: 07.02.2002 CRLF 11:35 CRLF In case of an error, the instrument transmits: “NAK”.
DELMSW	Deletes all readings of the open Application. As a confirmation, the instruments returns “ACK” or in case of an error “NAK”.
EN	Triggers the measurement acquisition. Measurement data are output by the instrument via the RS232 interface. The reading is not stored. With multi-channel measurements, only the reading of the selected probe / module board slot is transmitted. In case of an error, the instrument transmits: “-99999”.
ES	Starts the measurement. Each measurement is stored and output by the instrument via the RS232 interface. In case of an error, the instrument transmits: “-99999”.
GETND	Requests the number of coating thickness readings that the probe provides per measurement. Multi-channel application: The number of coating thickness values for the selected probe / module slot number are transmitted.

Command to MMS® PC2	**Description**
GETNX	Requests the number of count rate values that the probe supplies per measurement. Multi-channel application: The number of count rate values for the selected probe / module slot number are transmitted.
GETNXN	Requests the number of normalized count rate values that the probe supplies per measurement. Multi-channel application: The number of normalized count rate values for the selected probe / module slot number are transmitted.
GG	Requests the fixed block size of the open Application (measurement application memory/file), i.e., the set number for automatic block creation. “0” is output of automatic block creation is disabled. Enables/Disables automatic block creation: **File/Properties**, tab *Measurement*.
GGS	Requests the activation status of the group separator. After receiving the command, the instrument returns the following: “0” for group separator disabled, i.e., no group separator to identify a block closure is transmitted via the RS232 interface during data transfer. “1” for group separator enabled.
GNB	Requests the number of measurement blocks that are stored in the open Application (measurement application memory/file).
IE	Requests the number of individual measurements that are combined for an “averaged measurement) (i individual measurement). Setting i individual measurement: **File/Properties**, tab *Measurement*.
NAM	Requests the name of the open Application (measurement application memory/ file).
PBASS	Assigns the connected probe to the open Application. Multi-channel Applications: Assigns the probe that is connected to the selected module board slot to the Application. After the command is executed, the instruments returns “ACK” as a confirmation to the PC.
PBNAME	Requests the designation of the probe type (e.g., FGAB1.3). “Multi” is transmitted in case of multi-channel Applications.
PBSERNR	Requests the serial number of the probe. “Multi” is transmitted in case of multi-channel Applications.
PE	Requests the ASCII character that is set as the group separator in the instrument.
PG0	Sets the group separator in the instrument to “GS” (ASCII29).
PG1	Sets the group separator in the instrument to “,” (ASCII44).
PG2	Sets the group separator in the instrument to “*” (ASCII42).
PG3	Sets the group separator in the instrument to “;” (ASCII59).
PG6	Sets the group separator in the instrument to “#” (ASCII35).
PG7	Sets the group separator in the instrument to “:” (ASCII58).

Command to MMS® PC2	Description
PT0	Sets the measurement output of the instrument to “No output”. After the command is executed, the instruments returns “ACK” as a confirmation to the PC.
PT1	Sets the measurement data output of the instrument to “Transmit individual measurements without a group separator”. After the command is executed, the instrument returns “ACK” as a confirmation to the PC.
PT2	Sets the measurement data output of the instrument to “Transmit individual measurements with a group separator”. After the command is executed, the instrument returns “ACK” as a confirmation to the PC.
PT3	Sets the measurement data output of the instrument to “Transmit only block mean values”. After the command is executed, the instrument returns “ACK” as a confirmation to the PC.
PT4	Sets the measurement data output of the instrument to “Transmit block mean values with date”. After the command is executed, the instrument returns “ACK” as a confirmation to the PC.
RM0, RM1	Enable (1) or disable (0) remote control mode. No display error and warning messages appear in remote control mode. When the instrument is switched off, the enabled remote control mode (1) will be disabled. After the command is executed, the instrument returns “ACK” as a confirmation to the PC. In case of an error, the instrument transmits: “NAK”.
SAM	Requests measurement data / characteristic parameters of the open Application (measurement application /file) according to the settings in the tab *Online Output* under **Tools/Options**.
SDG	Requests the type of air count rate acquisition (from Application). After receiving the command, the instrument returns the following: “1” for dynamic, the air count rate is acquired continuously during the measurement. “2” for static, the air count rate is not acquired automatically but must be acquired manually (e.g., after each measurement).
SDS0, 1 or 2	Sets the air count rate acquisition. The setting will be stored in the open Application (not in the probe). Examples: Input: SDS0: The air countrate is acquired as preset in the probe. Input: SDS1: The air count rate is acquired dynamically (automatically during the measurement). Input: SDS2: The air count rate is acquired statically (must be done manually). After the command is executed, the instrument returns “ACK” as a confirmation to the PC. In case of an error, the instrument transmits: “NAK”.

Command to MMS® PC2	**Description**
STATE	Requests information on the current state of the instrument. After receiving the command, the instrument returns the following: “1” for instrument is ready to make measurements. “0” for instrument is not ready to make measurements (no or wrong probe, no Application (measurement application file) set up, etc.). “-1” for all states of the instrument not listed thus far.
SWA Directory\application name.app	Calls the Application (measurement application/file). Example: Input: SWA then press the ENTER key Input: \application data\test.app then press the ENTER key, After transmitting the command, the Application Test.app is called up in the instrument. The instrument responds with “ACK”. Response of the instrument in case of an error: “NAK”
SWD	Toggles the measurement display to coating thickness measurement data (d/µm). After the command is executed, the instrument returns “ACK” as a confirmation to the PC. In case of an error, the instrument transmits: “NAK”. **CAUTION:** This command can be performed only for Applications without measurement data! Delete existing measurement data first. Multi-channel Applications: This command affects only the the measurement display of the selected probe / multi-board slot number.
SWES0, 1, 2, 3 or 4	Sets the type of measurement acquisition (**File/Properties**, tab *Accept*). 0: Parameter “external start” is enabled 1: Parameter “upon touch-down” is enabled 2: Parameters “external start” and “upon touch-down” are enabled 3: Parameters “external start” and “automatic measurement” are enabled 4: Parameters “upon touch-down” and “automatic measurement” are enabled Input example: SWES4. 4: The parameters “upon touch-down” and “automatic measurement” are enabled. The measurement series starts automatically upon touch-down of the probe. After the command is executed, the instruments returns “ACK” as a confirmation to the PC. In case of an error, the instrument transmits: “NAK”.
SWX	Toggles the measurement display to count rate (X). After the command is executed, the instruments returns “ACK” as a confirmation to the PC. In case of an error, the instrument transmits: “NAK”. **CAUTION:** This command can be performed only for Applications without measurement data! Delete existing measurement data first. Multi-channel Applications: Command cannot be executed because fundamentally multi-channel Applications cannot toggle to count rate display.

Command to MMS® PC2	Description
SWXN	Toggles the measurement display to count rate (X). After the command is executed, the instrument returns “ACK” as a confirmation to the PC. In case of an error, the instrument transmits: “NAK”. **CAUTION:** This command can be performed only for Applications without measurement data! Delete existing measurement data first. Multi-channel Applications: Command cannot be executed because fundamentally multi-channel Applications cannot toggle to count rate display.
VV	Requests the instrument-internal software version (e.g., WCA07).
VVV	Requests the version of the operating system used in the instrument (e.g., Aug 19 2009 08:16:01).
XX or z	Requests the current count rate that is permanently supplied by the probe. Response of the instrument in case of an error: “NAK”
XN or y	Requests the current normalized count rate that is permanently supplied by the probe. Response of the instrument in case of an error: “NAK”
ZERO	Calls the normalization function (**Calibration/Normalization** ...).

6.5 Connection LAN

To connect the FISCHERSCOPE® MMS® PC2 to an Ethernet network for data backup and for direct data access from a network. In this manner Applications (measuring application files) can be stored from the MMS® PC2 directly in a network directory or can be called up directly. Print forms can be exported to the network via the LAN connection as well.

Network: Ethernet, transfer speeds 10 MBit/s or 100 MBit/s (automatic setting)

LAN connection: RJ45 socket

shows that a connection to the network exists.

shows that no connection to the network exists.

Establishing the connection to the network may take a few minutes if the network cable is plugged into the LAN socket when the instrument is already powered up.

Integrating the FISCHERSCOPE® MMS® PC2 into an Ethernet Network 6-30
Saving Applications in the Network Directory 6-36
Calling/Opening an Application from the Network Directory... 6-38

6.5.1 Integrating the FISCHERSCOPE® MMS® PC2 into an Ethernet Network

First, request the following information from your network administrator:

- IP address for the FISCHERSCOPE® MMS® PC2 instrument (example: 191.163.1.81)
- Subnet mask (example: 255.255.255.0)
- Standard gateway (example:191.163.1.250)
- Network drive (\\network computer\network drive)
- Name server (primary or secondary DNS and WINS; example: 191.163.1.250)
- Domain (example: COMPANY-DE)

If the IP addresses are assigned dynamically in your network, then the IP address, subnet mask and standard gateway information are not required.

The full keyboard is required **for entering** the network drive.
We recommend connecting a PC keyboard to the FISCHERSCOPE® MMS® PC2 (USB connection. The connection must be establish before powering up the instrument, otherwise the keyboard will not be recognized).

Alternative: **Calling up the display keyboard**

- Tap the  symbol with the stylus.
- Tap "Keyboard" from the pulldown menu.

It is paramount to observe the following when entering names, drive designations and paths:

- **Case sensitivity!**
- **Do not use spaces and special characters such as semi colon (;), comma (,), asterisk (*) etc.!**

Settings in the FISCHERSCOPE® MMS® PC2
(Powering up the instrument: ON/OFF key (it takes about 20 seconds to load the program))

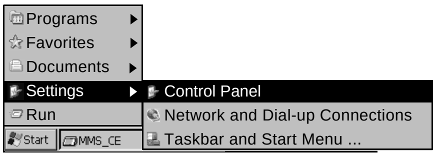
Procedure

1. Enter the instrument name.

Assign an unambiguous name to the MMS® PC2 that is not yet used in the network. When designating a name, please observe the notes from the tab *Instrument name* .

1. Open the window *Control Panel*:

Tap **Start** / **Settings** / **Control Panel** in succession using the stylus.



2. Open the *System Properties* window:

   Tap **System**, double-tap the  symbol.

3. From the *System Properties* window tap the tab *Device Name*.

Settings from the window *System Properties*, **tab** *Device Name*

4. Window *System Properties*, Tab *Instrument Name*:

   Field "Device Name:": enter an unambiguous instrument name. The instrument name can occur only once in the network.

   Field "Device Description:": No changes required.

5. Close the window: Tap **OK** in the blue title bar.

6. Close the *Control Panel* window: Tap **File** / **Close** in succession using the stylus.
   The measurement mode that appears automatically after powering up the instrument is again displayed on the screen.

2. Setting the Network Configuration for the LAN Connection

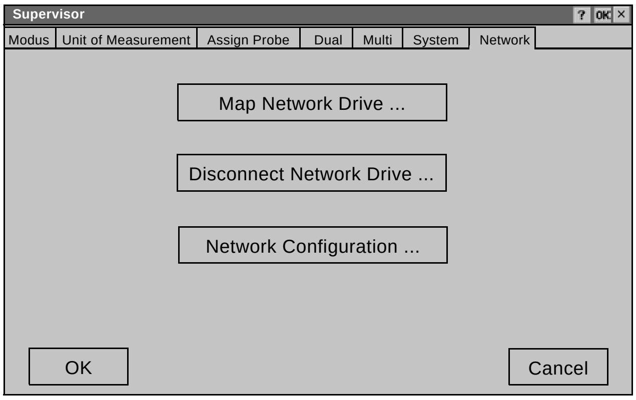
Open the *Supervisor* window, tab *Network*

1. Open the *Supervisor* window:
   Tap the menu **Tools** / **Supervisor** in succession using the stylus.

   Entering the password: Tap **1 5 9** in the entry area in succession and then the **OK** button.

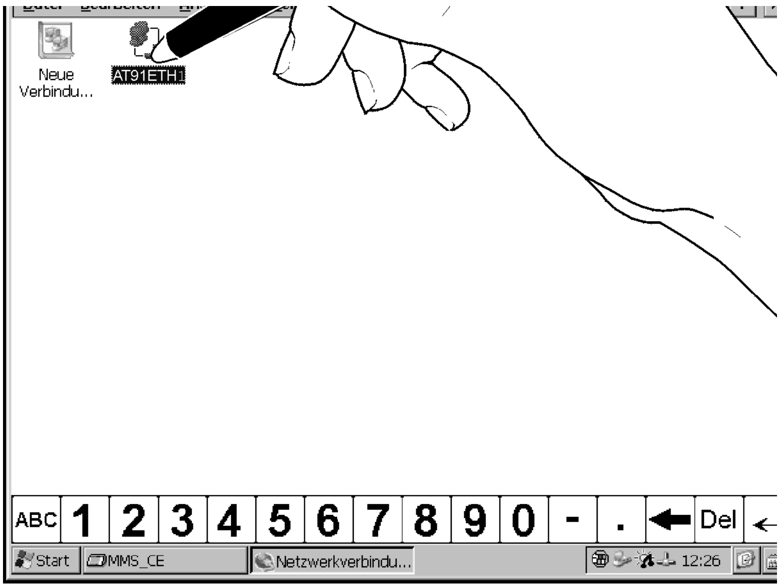
2. From the *Supervisor* window, tap the tab *Network*.

3. Opening the *Network Connection* window:



- Tap the **Network Configuration ...** button.

4. *Network Connection* window:



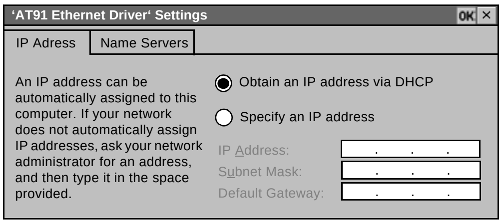
- Tap **AT91ETH1**. Double-tap the  symbol

  The window *'AT91 Ethernet Driver' Settings* opens.

Settings in the window *‘AT91 Ethernet Driver’ Settings*, **tab** *IP Address*

5. Window *’AT91 Ethernet Driver’-Settings,* tab *IP Address*:

   Select the type of IP address assignment. Request the respective assignment method and if applicable the addresses from your network administrator.



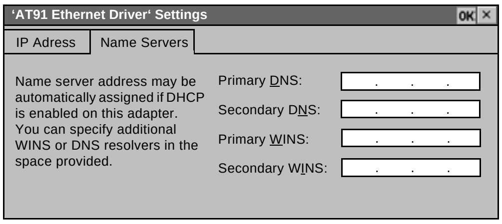
- Parameter "<u>Obtain an IP address via DHCP</u>": IP addresses are assigned dynamically.

  Parameter "<u>Specify an IP-address</u>": IP addresses need to be assigned.
  If this parameter is selected, the information for IP address, subnet mask and standard gateway must be entered into the fields below. To do this, tap the respective fields with the stylus.

6. From the *‘AT91 Ethernet Driver’ Settings* window, tap the tab *Name Server*.

Settings in the window *‘AT91 Ethernet Driver’ Settings*, **tab** *Name server*

7. Window *‘AT91 Ethernet Driver’ Settings*, tab *Name Server*:



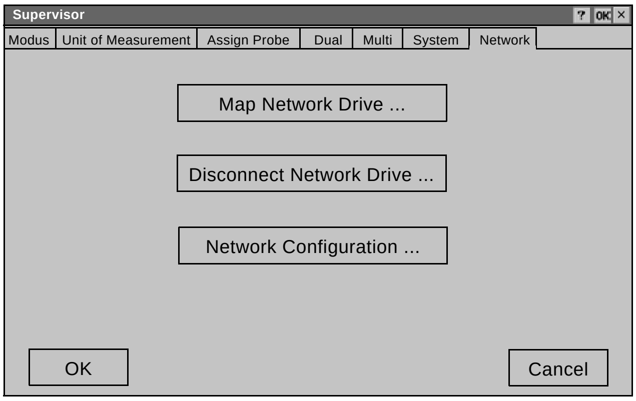
- Enter the addresses for "Primary or secondary DNS" and "WINS". You can obtain these addresses from your network administrator.
  To enter the addresses tap the respective fields using the stylus.

8. Closing the *‘AT91 Ethernet Driver’ Settings* window: Tap the **OK** button in the title bar of the window.

9. Close the *Network Connection* window: Tap **File / Close** in succession using the stylus.

3. Setting Up Network Access in the FISCHERSCOPE® MMS® PC2

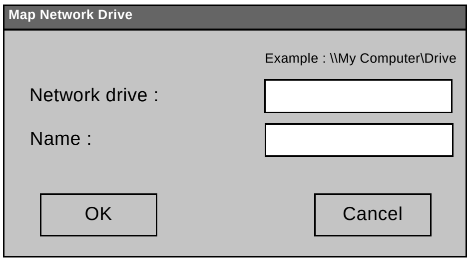
1. Window *Supervisor*, tab *Network*:



Settings in the *Supervisor* window, tab *Network*

- Tap the **Map Network Drive** button.
- The window *Map Network Drive* opens.

2. Window *Add Network*:



Settings in the window *Map Network Drive*

- Field "Network Drive": Enter the path for the network drive. You can obtain the path from your network administrator. To make entries tap the field with the stylus.

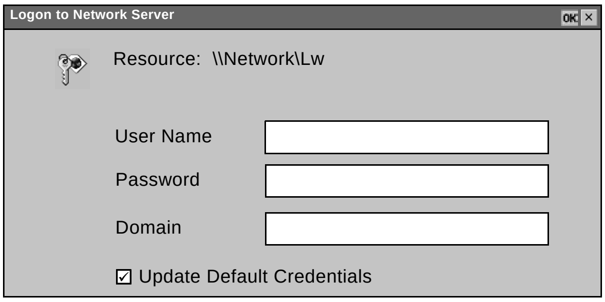
The full keyboard is required for entering the path. If a PC keyboard is not connected to the instrument, call up the display keyboard, 6-30.

The entry is case sensitive; do not use spaces or special characters!

- Field "Name": Enter any desired directory name (e.g.: LAN)

  A subdirectory with this name will be set up under the NETWORK directory in the FISCHERSCOPE® MMS® PC2. This subdirectory essentially provides the window/access to the respective network drive directory, where Applications can be saved and/or opened.

3. Closing the *Map Network Drive* window: Tap the **OK** button.
   A message will appear indicating that the network drive has been added. Tap **OK** from the message window.
4. Wait a short time (about 10 to 20 seconds).
   The window *Logon to Network Server* opens.
5. Window *Logon to Network Server*:



Settings in the window
Logon to Network Server

Enter your passwords that you will need to access your network under "User Name:" and "Password".
You can obtain the domain name from your network administrator. To do this, tap the respective fields with the stylus.

The parameter "Update Default Credentials" is enabled as the factory default setting. This means that in the future the entered network directory can be accessed by the MMS® PC2 without the typical login procedures. If this is not desired, the parameter can be disabled (no check mark).

6. Close the window *Logon to Network Server* Tap **OK** in the title bar of the window.
   A verification message appears. Close the message window with **Yes**.
7. Closing the *MMS PC* message window: Tap the **OK** button.
8. Closing the *Supervisor* window: Tap the **OK** button.

You are now able to save Applications in the network directory (example: \Network\Directory name).

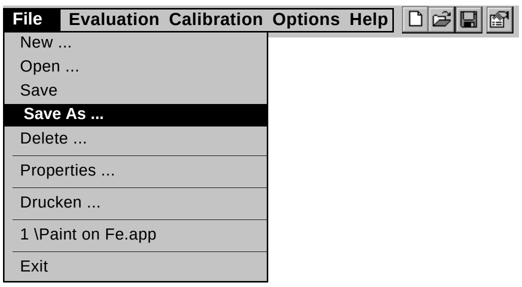
Verifying the accessibility of the FISCHERSCOPE® MMS® PC2 in the network:
The verification is done using the DOS command “Ping” followed by the IP address of the MMS® PC2 instrument (example 191.163.1.181). A PC that is connected to the Ethernet network is required. The entry is carried out from the DOS command prompt.
Entry example: Ping 191.163.1.181
A reply from the entered IP address indicates that the connection is OK.

6.5.2 Saving Applications in the Network Directory

The procedure for saving to the network is carried out using a sample Application.

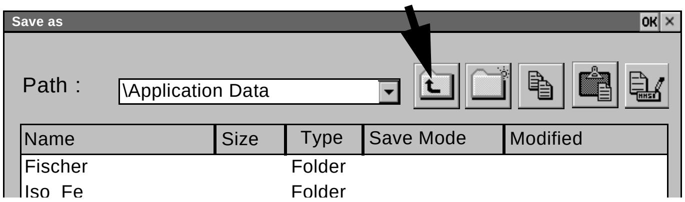
Procedure

1. Opening the window *Save As...* **:**



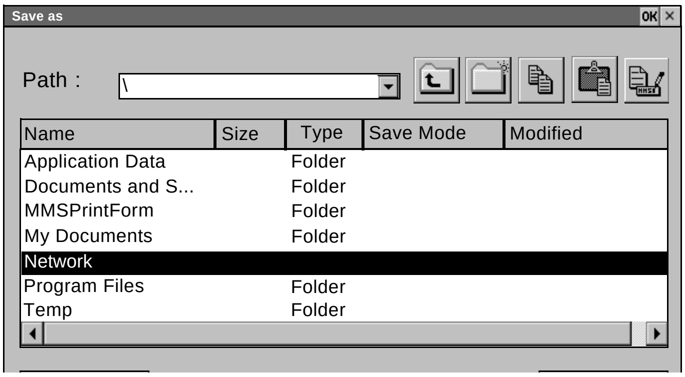
Tap **File / Save As ...** in succession with the stylus on the display.

2. Select the network directory:



1. Exit the current directory:

Tap .



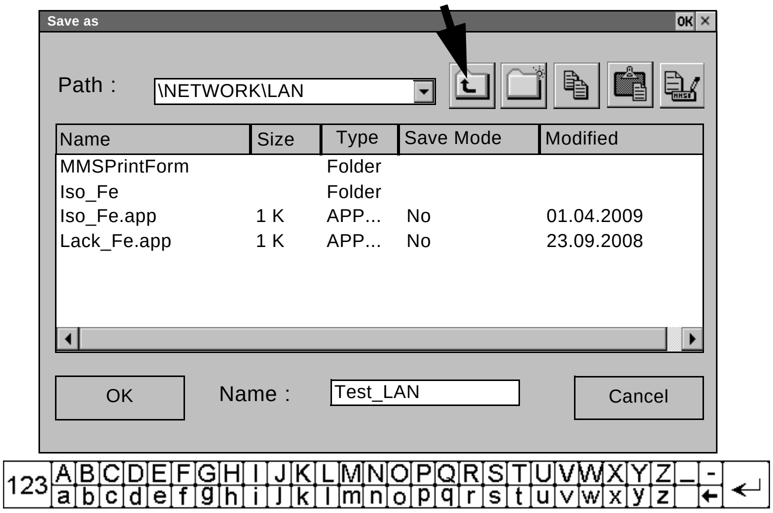
2. Double-tap the directory **NETWORK**.Networ

Depending on your setting, a password may be requested to access the network. Enter your user name and password for net access in the window *Logon to Network Server* You can obtain the domain name from your network administrator.

3. Double-tap the directory LAN (example name).

The LAN directory displays the contents of the network drive that has been entered previously in the Supervisor menu. Integrating the MMS® PC2 into an Ethernet Network, Page 6-30.

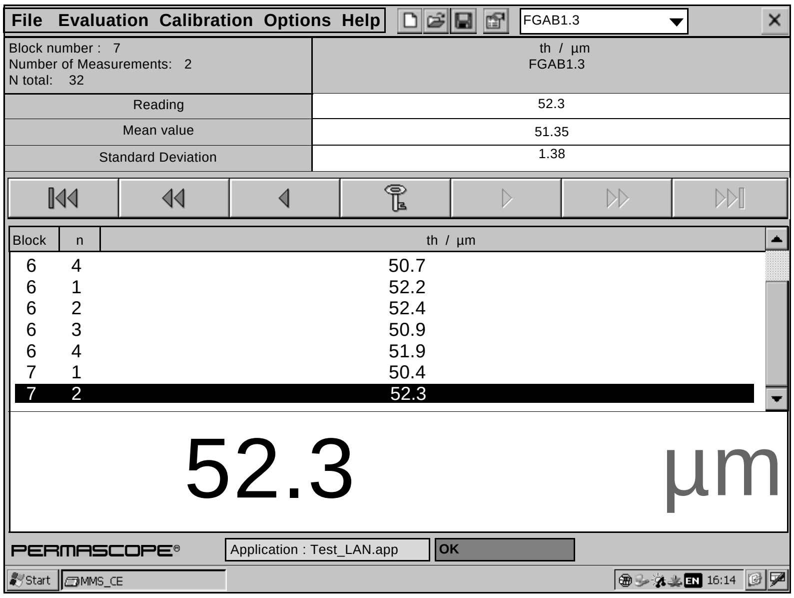
3. Assigning Application Names:



1. **Test_LAN** (example name) Use the stylus to tap in the “Name:” field. Use the stylus to tap the letters in succession in the character bar at the lower display edge.

If necessary, toggle the character bar to numbers or letters: Tap the 123 or ABC button on the left.

2. Saving the file in the selected directory: Tap the **OK** button.



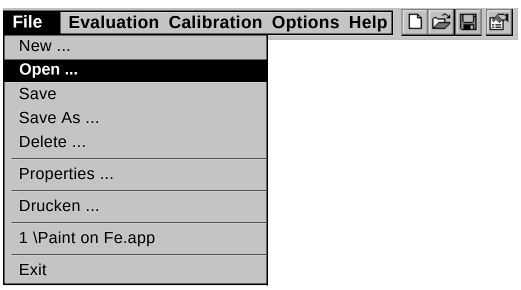
The displayed Application is now saved on the network and can be opened from there. 6-38.

6.5.3 Calling/Opening an Application from the Network

Opening of a network directory is demonstrated using a sample application.

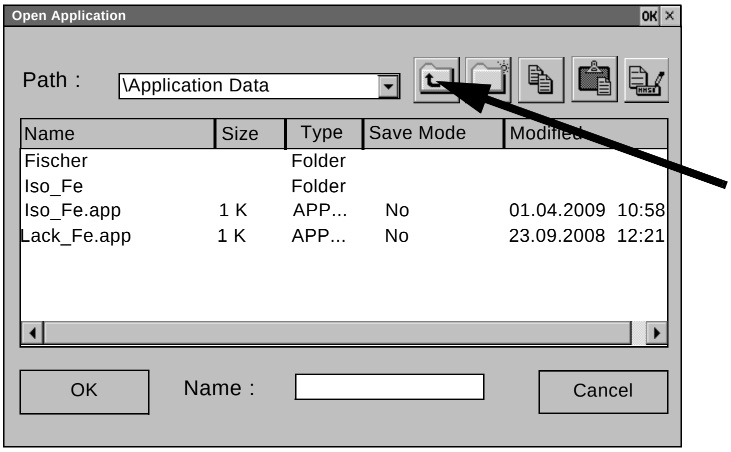
Procedure

1. Calling the window *Open Application***:**



Tap **File / Open ...** in succession with the stylus on the display.

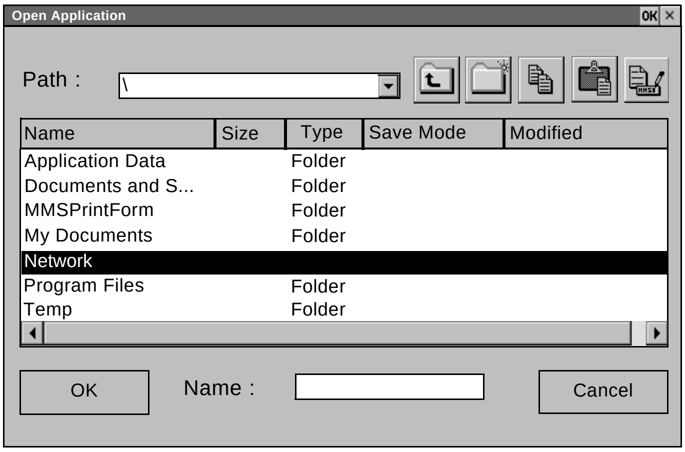
2. Selecting the network directory:



1. Exit the current directory:

Tap .

Applications in the network are always in the path “\NETWORK\...”.



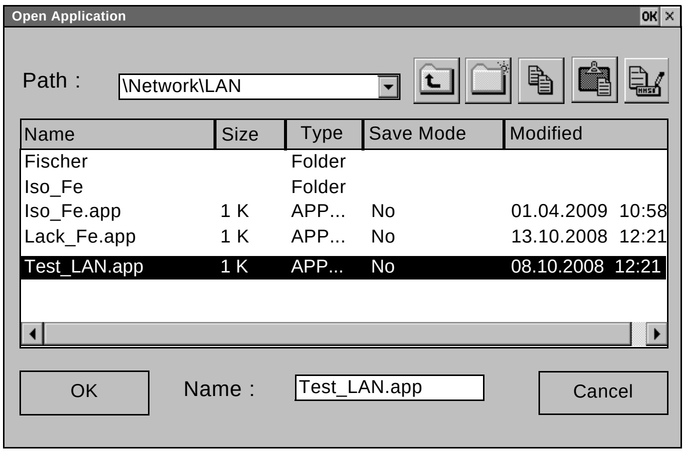
2. Double-tap the directory **NETWORK**.

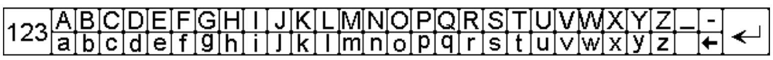
Depending on your setting, a password may be requested to access the network. Enter your user name and password for net access in the window *Registering on the net ...*. You can obtain the domain name from your network administrator.

3. Double-tap the directory LAN (example name).

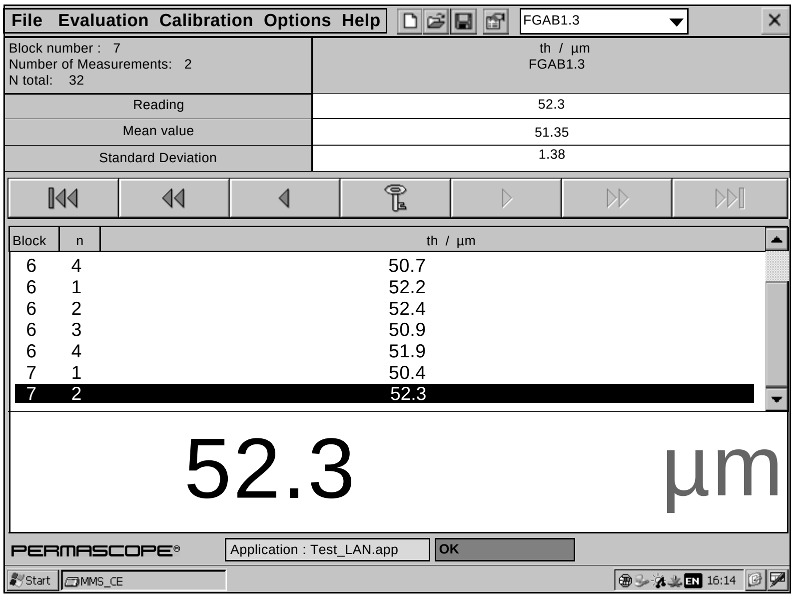
The LAN directory displays the contents of the network drive that has been set previously in the Supervisor menu. Integrating the MMS® PC2 into an Ethernet Network, Page 6-30.

3.





1. **Test_LAN** (example name) Double-tap the file name.



The desired Application opens.

Tapping  saves the changes (e.g., new measurement data) directly in the network directory, under the displayed Application name.

7 Automated Measuring

7.1 Simultaneous Measurements at Several Measurement Spots (Multichannel Measurement)

The FISCHERSCOPE® MMS® PC2 can be configured such that up to 8 readings can be obtained simultaneously and saved in an application (meas. application file). In this manner, simultaneous measurements are possible at up to 8 different measurement spots.

Required configuration for the multichannel measurement

- Probes:
  Up to 8 probes that operate according to the same measurement method (e.g., probe types FGAB and FKB, both probe types operate according to the magnetic induction method).
- Instrument population:
  According to the probes. Population with up to 8 modules operating according to the same measurement method (e.g., up to 8 PERMASCOPE® modules or up to 8 SR-SCOPE® modules, etc.).
- Menu setting of the software:
  The multichannel measurement requires the menu setting "Special Menu".

7.1.1 Measurement Procedure

Similar to measurements with only one probe per application (= meas. application file), applications-specific settings need to be made for the multichannel measurement as well; these include setting up and saving the application, and adapting the measuring system to the specimen.

1. Connecting the instrument to the power supply (100 ... 240 VAC, 50 ... 60 Hz) (Instrument connection "12VCD/1.2").
2. Connecting the probes to the respective modules of the instrument.
3. Powering up the instrument: Press the orange-colored **ON/OFF** key on the front of the instrument.
4. Set the instrument to "Special Menu" for the measurement and evaluation program (MMS_CE), 🗐 7-2. Basic program setting, to be done once only.

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5. Set up the file for the meas. application in the instrument (Set up Application), 🗐 7-3. / Call/open meas. application file (Application), 🗐 7-6.

---

6. Save the application (meas.application file) in the instrument, 🗐 7-5.

7. Take influencing parameters into account by adapting the measuring system (probes and instrument) to the specimen (normalization, corrective calibration), 7-7
8. Measure, 7-12.
9. View/print the evaluation (characteristic statistical parameters, graphical presentation), 7-12/7-13.

7.1.2 Setting the "Special Menu" for the measurement and evaluation program (MMS_CE)

The default setting for the measurement and application program (MMS_CE) is "Standard Menu". To perform all the settings required for multichannel measurements, the setting for the measurement and evaluation program (MMS_CE) must be "Special Menu".

Procedure for switching to "Special Menu":

1. Open the window *Supervisor*:
Tap Options / Supervisor ... on the display in succession using the stylus.

Enter password: **Tap the number 1 5 9** at the entry bar at the bottom of the display in succession using the stylus, then tap the **OK** command button.

Open the window *Supervisor*, Tab *Mode*

2. Select "Special Menu" from the one-line list box "Menu Selection".
Tab ▼ and select the desired menu.

Settings in the window *Supervisor*, Tab *Mode*

3. Confirm the selection with **OK**.
The *Supervisor* window closes.

Save the selection and close the *Supervisor* window

The menu setting is an instrument setting that is retained even after the instrument is switched off. After the instrument is switched on again, the measurement and evaluation program (MMS_CE) will again open in the special menu.

The "Special Menu" can be recognized only by the additional menu commands such as the command **Define Features ...** from the **Option** menu.

7.1.3 Set Up a New Measurement Application File (= Application) for the Multichannel Measurement

In a multichannel application (= multichannel measurement application file), some application-specific settings are predefined and the probe type to be used, the correction factors for the material properties as well as the shape of the specimen, obtained through normalization or corrective calibration, and the measurement data will be saved.

Procedure

1. Setting up an application with one probe:

Tap **File / New...** on the display in succession using the stylus.

You will find a comprehensive description of the procedure in the chapters for coating thickness measurements or electr. conductivity measurements, section "Setting up a new application".

---

1. Select one of the probes that are used for the multichannel measurement and tap on the **OK** button.

Window *Select probe*

The module position numbers, where the probes are connected, are listed under "Pos".

2. Tap the command button **Finish**.
In this case, the normalization (= material adjustment) is not necessary. It will be performed later for all probes.

Window *Normalization*

2. Configure the application for the multichannel measurement:

1. Tap **Options / Define Features ...** on the display in succession using the stylus.

Open window *Define Features*

2. Assign the desired probes to the open application:

   Select a probe from the list on the right ("Probes") and transfer it to the left list ("Application") using the button ◁◁ . Repeat the procedure for all desired probes.

Window *Define Features*

"Probes": List of all probes connected to the modules.

"Application": List of all probes that are assigned to the open application.

In the lists, the module position numbers appear under "Pos." and the designation of the probe type under "Probe".

3. Date/Time, Temperature

Window *Define Features*

If desired, the date and time can be displayed and saved with every single reading. Similar to step ***2.,*** select "Date / Time" from the "Probes" list and transfer it to the left "Application" list using the button [◂◂] .

List "Probes": Date / Time

If the instrument is equipped with the TEMPERATURE module, the temperature measured by the connected temperature sensor can be displayed and saved for every reading as well. The procedure corresponds to that for "Date/Time".

List "Probes": TEMPERATURE ,

is displayed only if the instrument is equipped with the TEMPERATURE module.

4. Settings for the measuring system adjustment:

Window *Define Features*

Tap the parameter to enable or disable the parameter.

☐ : Parameter disabled.

☑ : Parameter enabled (default setting).

Parameter:
"Perform normalization separately"

Parameter:
"Perform calibration separately"

Here, calibration is short for corrective calibration.

The adjustment of the measuring system to the specimen can be carried out in 2 ways:

☐ All probes undergo normalization or corrective calibration simultaneously in an adjustment procedure. This is useful if all probes measure on the same coating substrate material combination, and the test areas exhibit the same shapes (flat surface, same curvature radius, etc.).

☑ An adjustment procedure for the normalization or corrective calibration is carried out separately for each probe. This is useful if the probes measure on different materials or test surface curvatures.

This is mandatory for the following probe types: ED10/FD10, ETD3.3/FTD3.3, EDX10/FDX10, ESD20 xx, ESD2.4, ESG20, ESL080 and ESL080B as well as ES40, ES40HF and ES20.

3. Save settings for the application (= meas. application file):

1. Tap the **OK** button using the stylus.

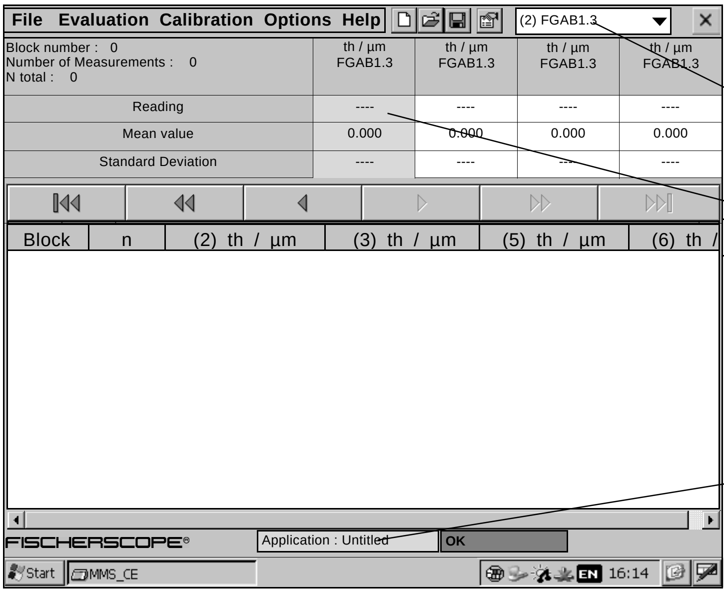
Window *Define Features*

2. Tap the **OK** button in the message window *MMS PC* using the stylus.

The windows *MMS PC* and *Define Features* will close and the measurement screen appears.

Window *MMS PC*

Notification that application settings have been changed and that, therefore, the measurement data as well as the existing normalization and corrective calibration parameters will be deleted.



Measurement screen of a newly set up application for multichannel measurements; shown is the example with probes FGAB1.3.

Selected module card slot (Example 2) and the connected probe type (Example FGAB1.3)

Data for the selected probe/Module card slot.

List header with the module card slots in use. The module position numbers are in parentheses. The readings appear in the respective columns under the header row.

Application name = File name, currently, no name is entered. A name is entered when the file is saved, ref. next Chapter.

7.1.4 Save measurement Application File (= Application)

To secure all settings carried out for the multichannel measurement application file, the file must be saved. To do this, the file will receive a name.

Applications that are not saved will be lost when the instrument is switched off!

Procedure

1. Tap **File / Save As ...** on the display in succession using the stylus.

Open the window *Save As*

2. Enter the application name (= file name):

   Tap the letters in succession on the entry bar at the bottom of the display using the stylus (for example, multichannel).

Window *Save As*

Entry field "Name"

If necessary, toggle the entry bar between letters and numbers: tap the left button **ABC** or **123**.

3. Tap the **OK** button using the stylus.

   The window *Save As* closes and you will be returned to the measurement screen. The entered application name (e.g., multichannel.app) will appear in the lower measurement screen row highlighted in yellow.

Measurement screen section of the lower row (Example):

Application : multichannel.app

You can find an extensive description of the procedure in the guidelines for coating thickness measurement or electr. conductivity measurement, Sections "Setting Up a New Application (File)".

7.1.5 Call/open the Measurement Application File (= Application)

Procedure

1. Tap **File / Open ...** on the display in succession using the stylus.

Open window *Open Application*

2. Select the desired file.

Window *Open Application*

3. Tap the button **Open** using the stylus.

   The window *Open Application* closes and the selected application will open on the measurement screen.

You will find a comprehensive description of the procedure in the guidelines for coating thickness measurements or electr, conductivity measurements, section "Calling an Application (File)".

7.1.6 Perform the Material Adjustment to the Specimen

Before measurements can be made in a new multichannel application (multichannel meas. application file), a material adjustment (= normalization) **must** be performed. Depending on the setting (Window *Define Features* of **Options / Define Features ...**), the adjustment is carried out separately for each probe, 7-7, or simultaneously for all probes, 7-9.

The influencing parameters that affect the measurements depend on the measurement method of the modules and probes used. The influencing parameters, required reference parts and the fundamental procedures for the material adjustment (called normalization or corrective calibration, respectively) are listed for each module and each measurement method up from chapter 2.9.

As a rule, a normalization is sufficient for the adjustment to the specimen. If the specified trueness is not maintained during a measurement after a normalization, a so-called corrective calibration should be performed.

Perform an adjustment to the specimen separately for each probe

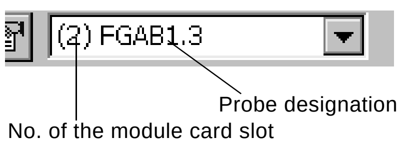
Required:

- ☑ : Parameter "Perform normalization separately" or "Perform calibration separately" is enabled in the window *Define Features*.
- **Imperative** for the following probe types for coating thickness measurement: ED10/FD10, ETD3.3/FTD3.3, EDX10/FDX10, ESD20 xx, ESD2.4, ESG20 as well as ESL080V and ESL080B.
- **Imperative** for all probes for electr. conductivity measurements: ES40, ES40HF, ES20 and ES24.

1. Select probe/Module card slot:

Select the desired probe from the one-line selection box in the upper right screen bar.
To differentiate between the probes, the number of the module card slot is placed in parentheses to the left of the probe designation.

One-line selection box for probe selection



2. Call the adjustment routine:

Tap **Calibration / Normalization ...** on the display in succession using the stylus.

Open window *Normalization*

Or

Or

Tap **Calibration / Corrective calibration ...** on the display in succession using the stylus.

Open window *Corrective Calibration*

You can find a description of the fundamental procedure for the normalization or corrective calibration, respectively for each module in the respective chapters beginning on 2.9.

3. Perform the adjustment routine

As mentioned above, the course of the adjustment routine is determined by the connected probe and measurement method used. Please obtain the fundamental procedure from the respective chapters for the modules, beginning from 2.9.

Window *Normalization* **or**
Window *Corrective Calibration*

BASE or Fe = Substrate material of the specimen without coating.

Saturation = Only the coating thickness to be measured with a minimum thickness that is dependent of the probe used.

4. Saving the normalization or corrective calibration in the open multichannel application:

Tap the button using the stylus.

5. Run through steps 1. to 4. for all probes of the multichannel application.

The actual measurement can start once the normalizations or corrective calibrations, respectively, have been carried out and saved for all probes.

Perform the adjustment to the specimen simultaneously for all probes

Required:

- ☐ : Parameter "Perform normalization separately" or "Perform calibration separately" is disabled in the window *Define Features*.
- **Not available** for the following probe types for coating thickness measurements: ED10/FD10, ETD3.3/FTD3.3, EDX10/FDX10, ESD20 xx, ESD2.4, ESG20 as well as ESL080B and ESL080V.
- **Not available** for all probes for electr. conductivity measurements: ES40, ES40HF,ES20 and ES24.

The readings will be displayed only after the instrument has obtained the measurements of all probes.

Procedure

1. Call the adjustment routine:

Tap **Calibration / Normalization ...** on the display in succession using the stylus.	**Open window** *Normalization*
Or	***Or***
Tap **Calibration / Corrective calibration ...** on the display in succession using the stylus.	**Open window** *Corrective calibration*

You can find a description of the fundamental procedure for the normalization or corrective calibration, respectively, for each module in the respective chapter, beginning from 2.9.

2. Perform the adjustment routine

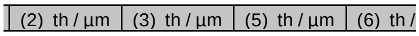
As mentioned above, the course of the adjustment routine is determined by the connected probe and measurement method used. Please obtain the fundamental procedure from the respective chapters for the modules, beginning from 2.9.

Window *Normalization* **or Window** *Corrective Calibration*

BASE or Fe = Substrate material of the specimen without coating.

Saturation = Only the coating thickness to be measured with a minimum thickness that is dependent of the probe used.

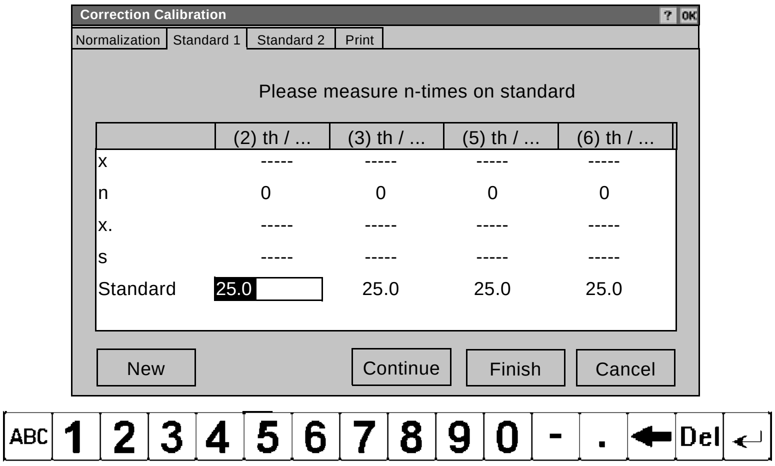
List of the module card slots in use. The data appear in the respective columns under the header row.



Example for a header bar

Entering the values for the standards (calibration foils)
For the corrective calibration, one or two values must be entered for each probe/module card slot for the standards used. Deviating from the descriptions in the chapters up from 2.9 the values for the standards are entered as follows:

Entering the standard values for the corrective calibration



1. Tap the line "Standard" using the stylus. The line will be highlighted in blue.

2. Double-tap the standard value in the respective slot position column.

The Figure to the left shows the double-tap for the module slot position # 2.

3. Enter the value for the standard using the entry bar at the bottom of the display.

4. Carry out steps **2.*1.*** to **2.*3.*** for all standards entries.

5. Tap the button **Continue** to continue the adjustment routine with a 2nd standard.

Tap the button **Finished** to

end the adjustment routine.

3. Saving the normalization or corrective calibration in the open multichannel application:

Tap the button  using the stylus.

The normalization or corrective calibration will now be saved in the open application.
Actual measurements can now start.

7.1.7 Measurement

- Always place the probe **gently and vertical** to the surface onto the specimen.
- When installing the probe, ensure that it has full contact and is vertical to the surface.
- Before the next measurement, the probe should be lifted off the surface by about 5 cm (about 2 inches). This is a rule of thumb and may vary from one probe to another.

The readings will be displayed only after the instrument has obtained the measurements of <u>all</u> probes.

Avoid shocks!

Do not allow the probe to hover over the surface! Doing so causes erroneous measurements! The probes must be switched to the "static measurement" mode (perform in the service menu) if it is not possible to comply the probe specific lift-off distance. In this case a air value measurement (= normalization) have to be performed at regular intervals. The air value measurement is mandatory necessary for accurate measurements! Please contact your Fischer agency for individual realization on-site.

The instrument can make measurements only when the measurement screen is displayed!

Do not bend the probe connection cable! This can break the wires! The bending radius of the cable should be greater than 5 cm (about 2 inches)!

7.1.8 Evaluation

The instrument saves the user from the sometimes complex and extensive mathematic calculations for the statistical evaluation of the measurement data. The evaluation is carried out for the respective open application. The measurement data can be displayed and printed in different configurations: listed as characteristic statistical quantities or graphically, for example in a cumulative frequency graph or as histogram. The graphical presentation for multichannel applications is done per probe/module card slot. This means, the desired probe/module card slot must be selected before calling the graphical presentation.

After every measurement accept, an evaluation of the measurements made since the close of the last block is carried out automatically in the background.

Calling the various evaluation presentations:

Tap the desired command in the menu **Evaluation** on the display using the stylus.

- Characteristic statistical quantities such as mean value, standard deviation, etc.

  Example: **Evaluation / Block result**
  for calling the statistical evaluations for the individual blocks / one block.

  You can find a description of the control buttons in the Chapter "Control Buttons - Symbols - Menus", page 1-11.

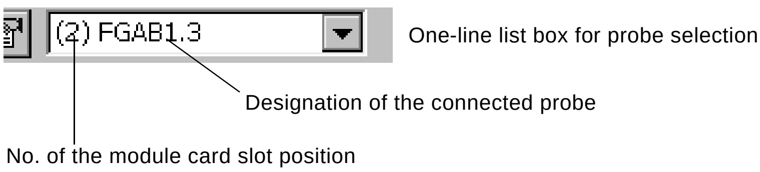
- Graphical measurement data presentations

  Example: **Evaluation / Probability Chart**
  for presenting the measurement data in a cumulative frequency graph.

For multichannel applications, the graphical presentation of the measurement data is always carried out per probe!

This means that the desired probe must be selected **before** calling the respective graphical presentation.

Probe selection: In the one-line list box in the right area of the upper screen line.



7.1.9 Print

You can find a description of the procedure in the chapters for coating thickness measurement or electr. conductivity measurement, sections "Printing".

DIGITAL I/O-Module for MMS PC2

Date 19.07.2011

Function

The DIGITAL I/O Module allows the communication between the MMS PC2 and an SPC (Stored Program Control) via binary signals. Up to 8 input signals and up to 24 output signals can be used.

Setup

The function of the input and output signals can be defined by user for each pin separately. The definition can be done within the supervisor menu using the “Digital I/O dialog”. This dialog appears only if a Digital I/O board is connected. The definition of the Digital I/O board is valid for all applications.

Functions of the input pins:

Not used	
External Start	Start measurement, set this line when Probe is <u>positioned</u> on specimen
Measure Xs	Start Xs measurement, set this line when Probe is <u>not influenced</u> by specimen. A measurement of the “Air Value” is done, which is taken for temperature compensation.

Functions of the output pins:

Not used	
Lower	signals last measurement is below lower limit
Higher	signals last measurement is above upper limit
Inside	signals last measurement is between lower and upper limit
Trigger Signal	signals whether MMS PC2 is ready to start the next measure or MMS PC2 is busy

The input pins are always valid for <u>all analog boards</u> whereas the output pins can be defined for <u>each analog board</u> separately. Every pin can be defined as active high or active low. All input pins are edge triggered.

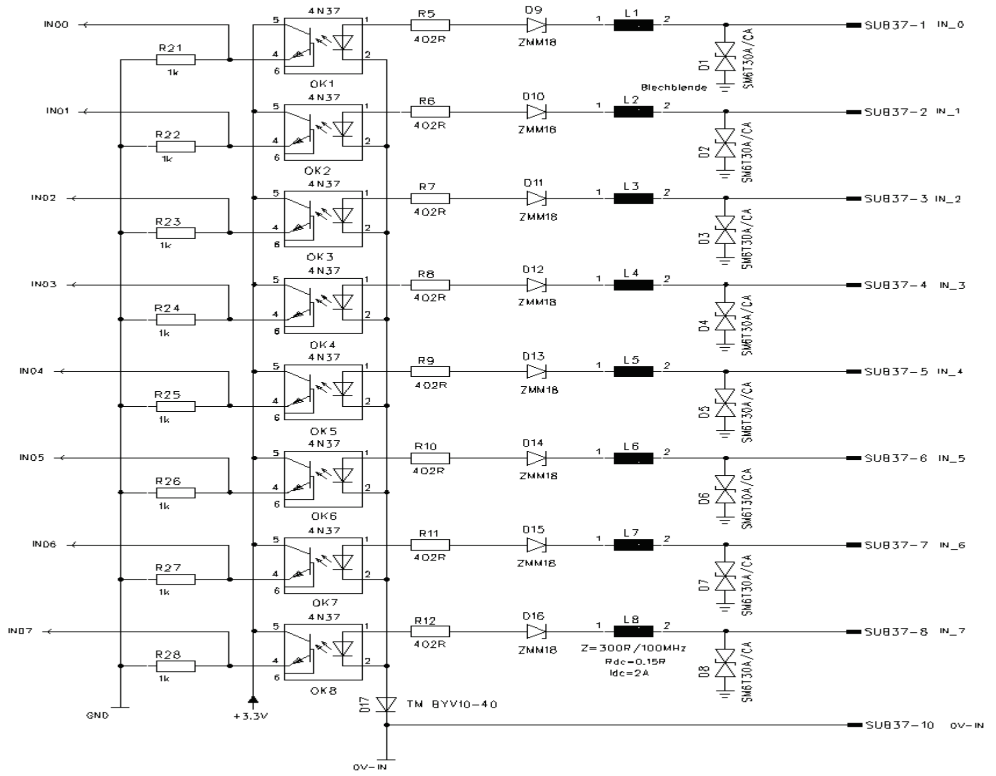
Connector

The Digital I/O board has a 37 pin Sub-D male connector. Pin assignment:

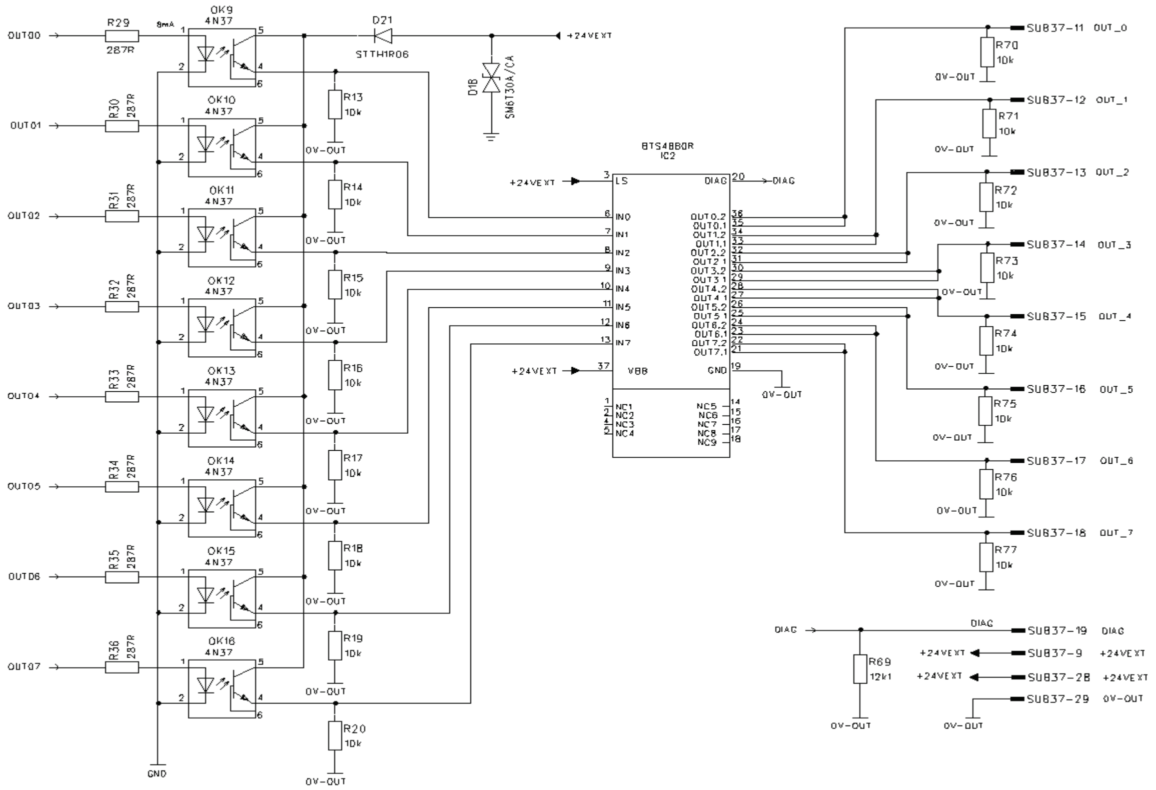
Pin	Hardware-Function	
1	IN_0	Input
2	IN_1	Input
3	IN_2	Input
4	IN_3	Input
5	IN_4	Input
6	IN_5	Input
7	IN_6	Input
8	IN_7	Input
9	24VEXT	Power Supply up to +24 V for output pins
10	0V-IN	Power supply GND (0V) for input pins
11	OUT_0	Output
12	OUT_1	Output
13	OUT_2	Output
14	OUT_3	Output
15	OUT_4	Output
16	OUT_5	Output
17	OUT_6	Output
18	OUT_7	Output
19	DIAG	Common diagnostic output for overtemperature
20	OUT_8	Output
21	OUT_9	Output
22	OUT_10	Output
23	OUT_11	Output
24	OUT_12	Output
25	OUT_13	Output
26	OUT_14	Output
27	OUT_15	Output
28	24VEXT	Power supply +24 V for output pins
29	0V-OUT	Power supply GND (0V) for output pins
30	OUT_16	Output
31	OUT_17	Output
32	OUT_18	Output
33	OUT_19	Output
34	OUT_20	Output
35	OUT_21	Output
36	OUT_22	Output
37	OUT_23	Output

DIAG Pin see manual BTS4880R(Infineon).

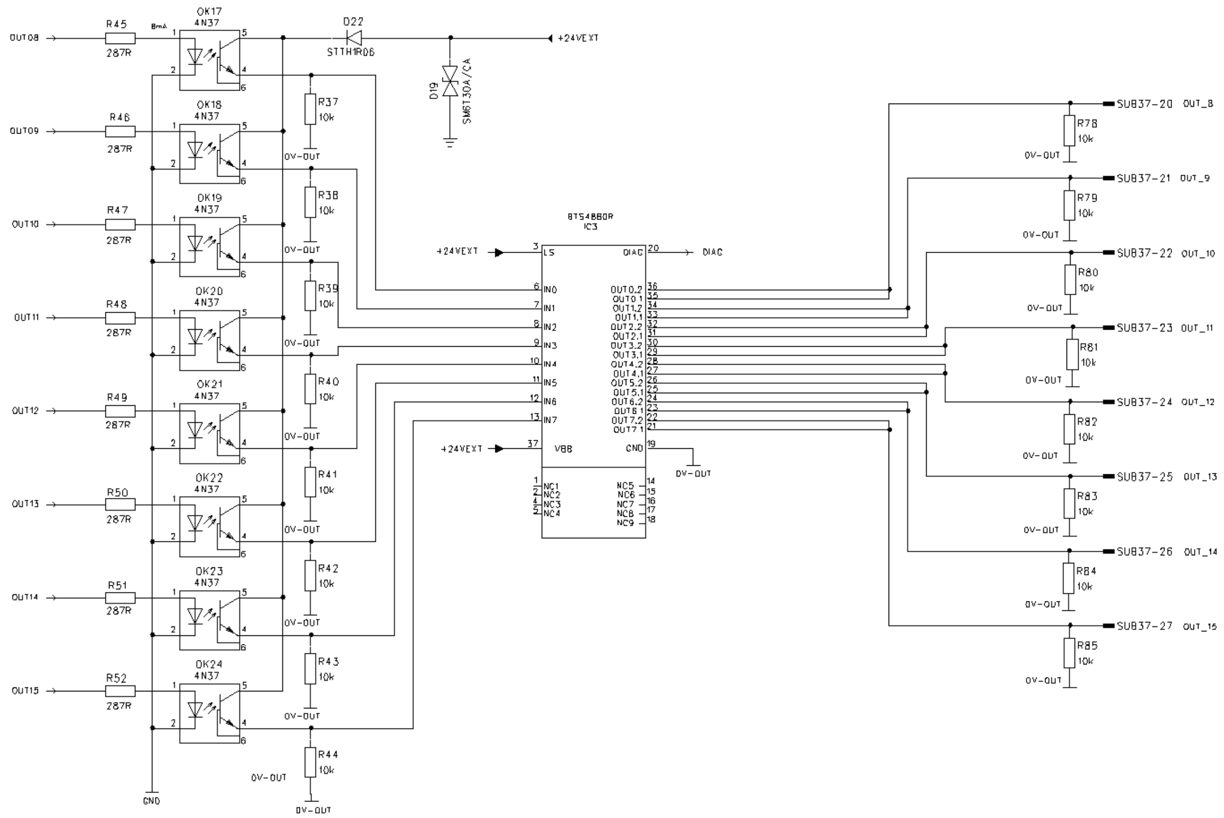
Circuits Inputs



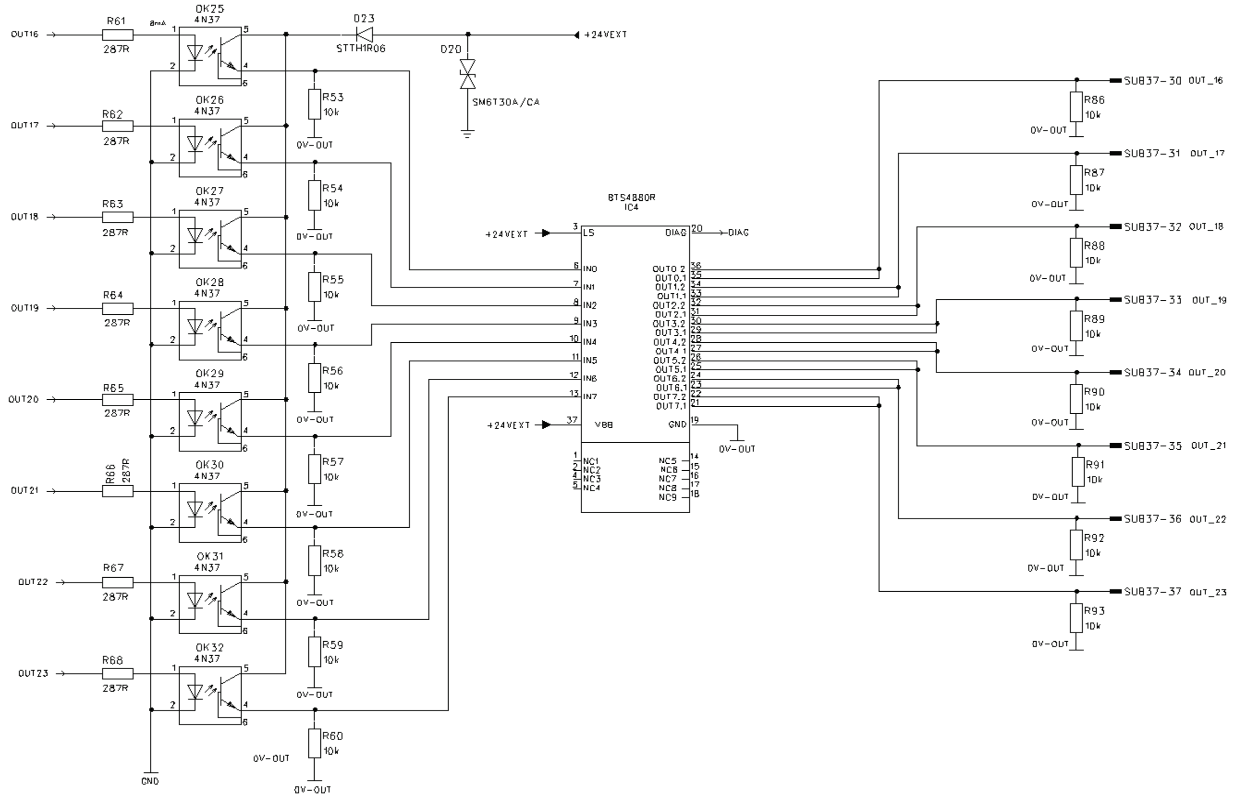
Circuits Outputs 0 - 7



Circuits Outputs 8 - 15

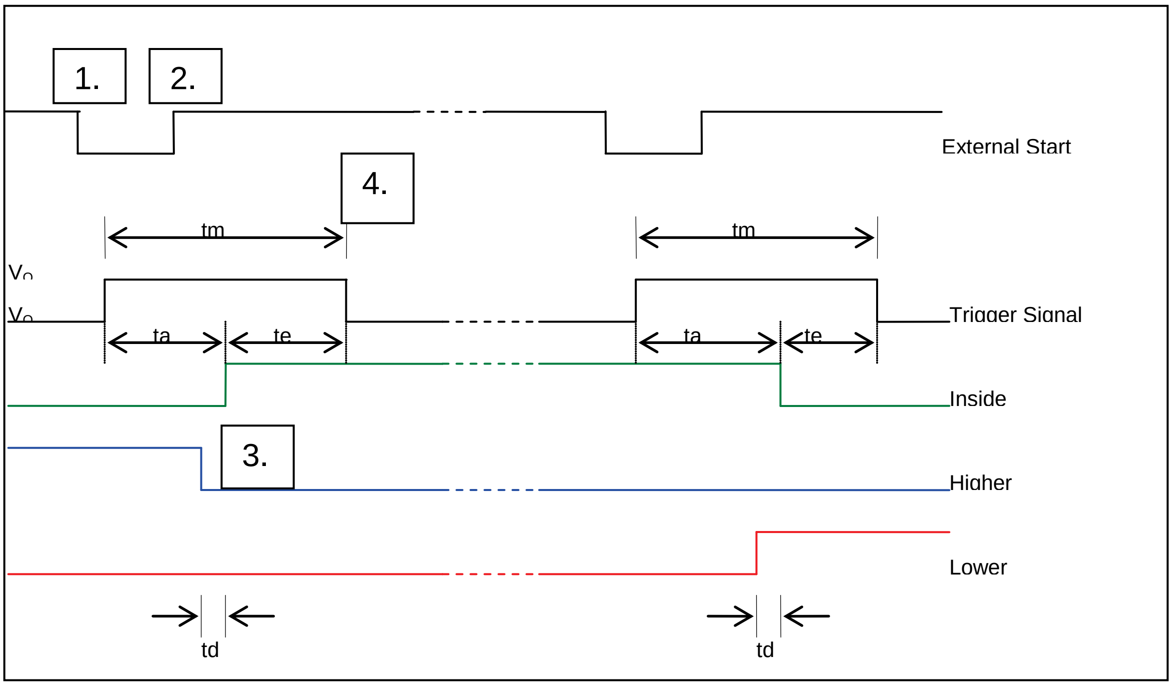


Circuits Outputs 16 - 23



Timing Diagram

1. A Measurement is started by setting the probe on the specimen or by changing the External Start signal to low.
   Trigger Signal rises and signals the measurement is in progress.
2. External Start can be removed after Trigger signal shows the measure is in progress.
3. The outputs signalling the information related to the tolerance limits are set to their proper value.
4. Trigger Signal falls and signals the end of the measurement. At this point, the information of the signals “Inside”, “Higher” and “Lower” should be read. These signals will keep their information until the next measurement is done.



In this diagram the previous measurement (outside the diagram) has been above the upper limit. The value of the first measurement shown is between the limits while the value of the last measurement is below the specified lower limit.

External Start is specified “High->Low” as active.
Trigger Signal, Inside, Higher and Lower are specified “High” as active.

Symbol	**Meaning**	**Min.**	**Typ.**	**Max.**	**Unit**
tm	Measurement is in progress	180	200	---	ms
ta	Begin of measurement to setting of the limit signals	90	100	---	ms
te	Setting of the limit signals to end of the measurement	90	100	---	ms
td	Changing of limit signals, signals may be inconsistent	6	10	---	ms

Electrical characteristics

See also Datasheet BTS4880R from Infineon

Symbol	**Meaning**	**Min.**	**Typ.**	**Max.**	**Unit**
V_{IH}	Input Voltage for High Level	21	24	27	V
V_{IL}	Input Voltage for Low Level	0	0	18	V
I_O	Output Current per signal line	---	---	500	mA
V_{OH}	See note				
V_{OL}	See note				

Note:

V_{OH} equals external Power Supply V_{Ext} at Pin 9 and Pin 28
V_{OL} equals external Power Supply $0V_{out}$ at Pin 29

Controlling normalization and calibration with input and output signals

(Only implemented in versions WCA15 and higer)

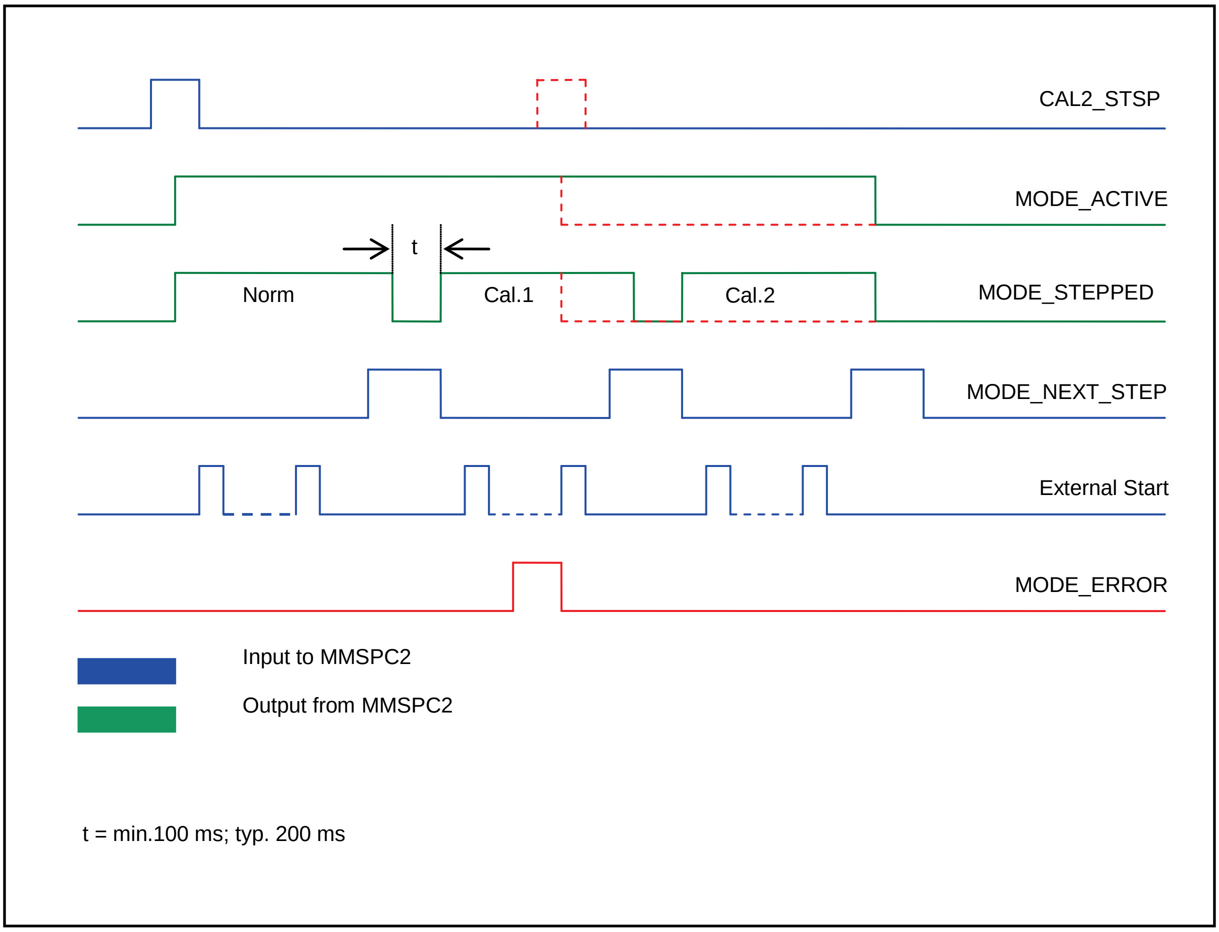
Normalization and calibration can be controlled by special input and output signals. All signals are edge triggered and can be definied in the "Digital I/O dialog".

Signal	**Direction (MMSPC)**	**Decription**
NORM_STSP	Input	Starts and stops the normalization
CAL1_STSP	Input	Starts and stops calibration with 1 calibration standard
CAL2_STSP	Input	Starts and stops calibration with 2 calibration standards
MODE_STEPPED	Output	Signals that MMSPC2 is in a normalization or calibration step
MODE_NEXT_STEP	Input	Prompt the MMSPC2 to switch in the next normalization or calibration step
MODE_ACTIVE	Output	Signals that the MMSPC2 is in the normalization or calibration mode
MODE_ERROR	Output	Signals that an error occurred. The normalization and calibration will be aborted
TRIGGER_SIGNAL	Output	Signals a measurement as described above
EXTERNAL_START	Input	Prompt the MMSPC2 to start a measurement as described above

Timing Diagram

The timing diagam shows an example of a 2 point calibration.

1. Start the 2 point calibration with the *CAL2_STSP* signal
2. The MMSPC2 starts the 2 point calibration with a normalization. The *MODE_ACTIVE* goes active. The *MODE_STEPPED* signal goes also active to show the first step (normalization).
3. Make several measurements. Use the *External Start* signal and the *Trigger Signal* (see timing diagram above).
4. To confirm the measurements pulse the *MODE_NEXT_STEP* signal. The MMSPC2 switches into the step of calibrating the first standard.
5. Make several measurements like in the normalization step.
6. Switch into the step of calibration the second standard.
7. Make serveral measurements
8. To confirm the measurements and end the calibration pulse the *MODE_STEP_NEXT* signal again.
9. The calibration has finished. The *MODE_ACTIVE* signal goes inaktiv.



Abort normalization or calibration

To abort the normalization or calibration pulse the *CAL2_STSP* signal while the *MODE_ACTIVE* signal is active. *The MODE_ACTIVE* signal and the *MODE_STEPPED* signal will go inactive.

Error handling

If an error occurs while normalizating or calibrating, the *MODE_ERROR* signal will go active. The normalization or calibration is no longer valid and should be aborted. Therefore pulse *the CAL2_STSP* signal. The signals *MODE_ERROR*, *MODE_ACTIVE* and *MODE_STEPPED* go inaktiv.

8 Lexicon

8.1 Description of the Characteristic Statistical Parameters

Block result

Parameter	Description	Equation
Mean Value	Mean value of the single readings, called arithmetic mean value (x.). The arithmetic mean value x. is the summation of all single readings x_i of a measurement series (block/group), divided by the number n of measurements.	$x. = \frac{1}{n} \cdot \sum_{i=1}^{n} x_i$ x. = Mean value of the block x_i = Single readings n = Number of measurements per block
Standard Deviation	The standard deviation is a measure of the deviations of the single readings of a measurement series from their common mean value.	$s = \sqrt{\frac{1}{(n-1)} \cdot \sum_{i=1}^{n} (x. - x_i)^2}$ s = Standard deviation x. = Mean value of the block x_i = Single readings n = Number of measurements per block
Coefficient of Variation	Deviations of a measurement series (block/group) in percent.	$V = \frac{s}{x.} \cdot 100[\%]$ V = Coefficient of variation s = Standard deviation x. = mean value of the block
Range	Difference between the maximum and the minimum measurement value of the block.	$R = x_{max} - x_{min}$ R = Range x_{max} = Highest reading of the block x_{min} = Lowest reading of the block
Minimum value	Lowest reading of the block.	
Maximum value	Highest reading of the block.	
Number of Measurements	Number of single readings per block = number of measurements per block.	
*Lower specification limit (LSL)	Lower specification limit value setup in the application	
*Upper specification limit (USL)	Upper specification limit value setup in the application	
*Values lower LSL	Number of measurements that are below the lower specification limit (LSL).	
*Values upper USL	Number of measurements that are above the upper specification limit (USL).	

* Statistical parameters are displayed (printed) only if the limit monitoring is enabled.

8.1.1 Final Result

for an Application with Automatic Block Creation (Fixed Block Size Enabled)

Parameter	**Description**	**Equation**
Total Mean Value	Mean value of the block mean values. x.. is the summation of all block mean values $x._i$ of a measurement series, divided by the number nbl of blocks.	$x.. = \frac{1}{nbl} \cdot \sum_{i=1}^{nbl} x._i$ x.. = mean value of the block mean values $x._i$ = Block mean values nbl = Number of blocks
Confidence interval	Each measurement device delivers random measurement errors. With a high probability (confidence interval), the presumed "true" value μ of the measured parameter is in an interval (double-sided confidence interval) around the measured mean value x.. of a measurement series (block/group). The borders of this interval are at a distance q from the "true" value μ. $x.. - q \leq \mu \leq x.. + q$	q is calculated according to the equation below assuming a normal distribution for a confidence interval of 95 % (1 - α): $q = t_{f;1-0.025} \cdot \frac{s}{\sqrt{nbl}}$ q = absolute distance of the confidence level t = Student's factor; f = nbl - 1 Quantile $t_{f;P}$ of the t-distribution can be obtained from common table publication [1]. s = Standard deviation $s = \sqrt{\frac{1}{nbl-1} \cdot \sum_{i=1}^{nbl} (x.. - x._i)^2}$ nbl = Numbers of blocks x.. = Mean value of the block mean values $x._i$ = Block mean values
Estimated standard deviation Sigma^	Estimated value for the standard deviation σ of the populalation. Will be displayed or printed only with fixed block size enabled.	$\hat{\sigma} = \frac{R.}{d_2}$ $\hat{\sigma}$ = Estimated standard deviation R. = Mean range d_2 = factor depending on the number of measurements and can be obtained from any popular publication of mathematical ststistics table Calculation for specified limits: $\hat{\sigma} = \frac{USL - LSL}{6 \cdot C_p}$ $\hat{\sigma}$ = Estimated standard deviation USL=Upper limit value LSL=Lower limit value cp = Capability factor
Estimated Coefficient of Variation	Estimated value for the percentage standard deviation of a series of measurement.	$\hat{V} = \frac{\sigma}{x..} \cdot 100[\%]$ $\hat{V}$ = Esrimated value for the Coefficient Of Variation $\hat{\sigma}$ = Estimated standard deviation x.. = Total mean value

Parameter	**Description**	**Equation**
Mean Range	Mean range of the block ranges.	$R. = \frac{1}{nbl} \cdot \sum_{i=1}^{nbl} R_i$ R. = Mean range Ri = Ranges of the blocks nbl = Number of blocks
Number of blocks	Number of blocks.	
*Lower Specification Limit (LSL)	Lower specification limit	
*Upper Specification Limit (USL)	Upper specification limit	
*Values lower LSL	Number of measurements that are below the lower specification limit (LSL).	
*Values upper USL	Number of measurements that are above the upper specification limit (USL).	
Block size	Number of single readings per block.	
Standard deviation sa	It describes the deviation of the block mean values in relation to the deviations of the single measurements within the blocks. With a suitable strategy, sa is a measure of the product deviation. Calculated only when the deviations of the block mean values cannot be attributed to the deviation within the subgroups, as determined by analysis of variance methods. For calculation a minimum of 5 blocks are necessary.	$sa = \hat{\sigma} \cdot \sqrt{\frac{F_{beo} - 1}{nbl}}$ sa = Deviation of the block mean values $\hat{\sigma}$ = Estimated value of the mean standard deviation nbl = Number of blocks F_{beo} = Quantile of F-Distribution (observ), with s_{II} as deviation of the block mean values from the total mean value $F_{beo} = \frac{s_{II}}{\hat{\sigma}^2}$ $= \sqrt{n_i} \cdot \sqrt{\frac{1}{nbl - 1} \cdot \sum_{bl = 1}^{nbl} (x._{bl} - x..)^2}$ $x._{bl}$ = Block mean value $x.._{bl}$ = Mean value of the block mean value nbl = Number of blocks n_i = Block size; number of single readings per block

Parameter	Description	Equation
*Cp	Capability factor Computed and displayed when specification limits are enabled.	$Cp = \frac{USL - LSL}{6 \cdot \hat{\sigma}}$ USL=Upper specification limit LSL=Lower specification limit $\hat{\sigma}$ =Estimated value for the mean standard deviation s. $\hat{\sigma}^2 = \frac{1}{nbl} \cdot \sum_{i=1}^{nbl} s_i^2$ nbl =Number of blocks s_i =Standard deviations of the block mean values
*Cpk	Capability factor Computed and displayed only when specification limits are enabled.	$Cpk = Min\{C_{pu};C_{po}\}$ $C_{pu} = \frac{\bar{\bar{x}} - LSL}{3 \cdot \hat{\sigma}}$; $C_{po} = \frac{USL - \bar{\bar{x}}}{3 \cdot \hat{\sigma}}$ USL=Upper specification limit LSL=Lower specification limit $\bar{\bar{x}}$ =Mean value of the block mean values $\hat{\sigma}$ =Estimated value for the mean standard deviation s. $\hat{\sigma}^2 = \frac{1}{nbl} \cdot \sum_{i=1}^{nbl} s_i^2$ nbl =Number of blocks s_i =Standard deviations of the blocks mean values

* Statistical parameters are displayed (printed) only if the limit monitoring is enabled.

[1] Graf, Henning, Stange und Wilrich: Formeln der angewandten mathematischen Statistik *(Equations in Applied Mathematical Statistics)*; Springer Verlag *(Springer Publishing Company)*

8.1.2 Final Result

for an Application with Manual Block Creation (Fixed Block Size Disabled)

Parameter	Description	Equation
Mean value	Mean value of the single readings, called arithmetic mean value (x.). The arithmetic mean value x. is the summation of all single readings x_i of a measurement series, divided by the number n of measurements.	$x. = \frac{1}{n} \cdot \sum_{i=1}^{n} x_i$ x. = Mean value of the single readings of all selected blocks x_i = Single readings of all selected blocks n = Number of all measurements
Confidence interval	Each measurement device delivers random measurement errors. With a high probability (confidence interval), the presumed "true" value μ of the measured parameter is in an interval (double-sided confidence interval) around the measured mean value x. of a measurement series (block/group). The borders of this interval are at a distance q from the "true" value μ. x. - q ≤ μ ≤ x. + q	q is calculated according to the equation below assuming a normal distribution for a confidence level of 95 % (1 - α): $q = t_{f;1\text{-}0.025} \cdot \frac{s}{\sqrt{n}}$ q = absolute distance of the confidence interval t = Student's factor; f = n - 1 Quantile $t_{f;P}$ of the t-distribution can be obtained from common table publications [1]. s = Standard deviation n = Number of measurements
Standard Deviation	The standard deviation is a measure of the deviations of the single readings of a measurement series from their common mean value.	$s = \sqrt{\frac{1}{(n-1)} \cdot \sum_{i=1}^{n} (x. - x_i)^2}$ s = Standard deviation x. = Mean value of the single readings of all selected blocks x_i = Single readings of all selected blocks n = Number of all measurements
Coefficient of Variation	Deviation of a measurement series in percent.	$V = \frac{s}{x.} \cdot 100[\%]$ V = Coefficient of variation s = Standard deviation x. = Mean value of the single readings of all selected blocks
Range	Difference between the highest and the lowest reading of all selected blocks.	$R = x_{max} - x_{min}$ R = Range x_{max} = Highest reading of all selected blocks x_{min} = Lowest reading of all selected blocks
Minimum value	Lowest single reading of all selected blocks.	
Maximum value	Highest single reading of all selected blocks.	

Parameter	Description	Equation
Number of measure-ments	Number of single readings of all selected blocks.	
*Lower Specification Limit (LSL)	Lower Specification Limit LSL.	
*Upper Specification Limit (USL)	Upper Specification Limit USL.	
*Values lower LSL	Number of measurements that are below the lower specification limit (LSL).	
*Values upper USL	Number of measurements that are above the upper specification limit (USL).	

* Statistical parameters are displayed (printed) only if the limit monitoring is enabled.

[1] Graf, Henning, Stange und Wilrich: Formeln der angewandten mathematischen Statistik *(Equations in Applied Mathematical Statistics)*; Springer Verlag *(Springer Publishing Company)*

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Numerics

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