Operator's manual

DELTASCOPE® MP10E
ISOSCOPE® MP10E
DUALSCOPE® MP20E-S

RS232 interface

Certified according to ISO 9001 : 2000

DKD-K-33101

Manual order no. 902-585
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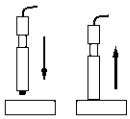
Table of Contents

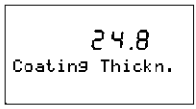
For Your Notes.

1 Conventions

1.1 Symbols and Styles Used

The following symbols and styles are used in this operator manual:

	Indicates safety remarks and warnings of possible damage to the instrument or the accessories or danger to the operating personnel
☛	Indicates particularly important information and notes
•	Indicates listings
Switching ... ON:	Indicates sequence of actions, which have to be performed (e. g.: switching the instrument ON)
➙ "5 Measurement"	Cross reference to a chapter of this operator manual
➙ *Histogram*	Cross reference to an additional term, that is also explained in chapter "11 Glossary of Terms and Symbols"
/ 1 /	Cross reference to additional literature, listed in chapter "12 Additional Literature" (from page 87)
	Indicates a measurement, which has to be performed as next action (perform the measurement with the probe connected! The axial single tip probe is used only as symbol for all probes, which can be connected!)
ENTER	Refers to instrument keys (e. g. **ENTER** key)
ON/OFF + ENTER	Refers to instrument keys, which have to be pressed immediately one after the other (do not keep both keys pressed!)



Simplified representation of the display with all elements relevant for the current action

`Delete: DEL` — Style used for those prompt lines on the display, which are displayed alternately with the lines appearing above them

`[Skip: ENTER]` — Styles used for operating notes appearing in the prompt lines on the display

`[E022]` resp `E022` — Style used for error messages and warnings appearing in the display

1.2 Abbreviations

The following abbreviations are used in this operator manual:

Abbreviation	Explanation
SM	substrate material (= uncoated measuring object)
NF	non-ferromagnetic
Fe	ferromagnetic
NC	electrically non-conducting
CuBe	Copper-Beryllium

Table 1.1: Abbreviations Used

1.3 General Note

☛ Illustrations of displays in this manual are examples only. Actual coating thickness measurement data and the prompt lines on the display depend on your individual application. It is possible that different numbers appear in the display. This is not an indication of any malfunction.

2 Notes Concerning the Operation of the Instruments and Handling the Accessories

2.1 Proper Use of the Instruments

The instruments DELTASCOPE® MP10, ISOSCOPE® MP10 and DUALSCOPE® MP20 are suitable for coating thickness measurement only.
In addition, only accessories recommended or used by Fischer (e. g. probes) may be connected to the instrument.

2.2 Requirements on the Operating Personnel

☛ The instruments should be operated by suitably qualified personnel only!

2.3 Environmental Conditions for Operation and Storage of Instrument and Accessories

The instruments DELTASCOPE® MP10, ISOSCOPE® MP10 and DUALSCOPE® MP20 are designed to meet and comply with all requirements as set forth in the EC Guideline 89/ 336/ EEC "Electromagnetic Compatibility". The measured coating thicknesses are not influenced by the highest level of interferance as stated in the guideline EN 50082-1 (which refers to IEC 801-2, 801-3 and 801-4).
In particular, the instrument is effectively shielded from electromagnetic fields (e. g. motors, power lines, etc.).

Instrument and accessories are designed for use at temperatures between 5 and 45 °C (41 ... 113 °F). The equipment may be stored at temperatures between 5 and 60 °C (41 ... 140 °F).

Temperatures behind windows (e. g. in cars) in direct sunshine rise easily above 60 °C (140 °F). To avoid damage to the instrument or the accessories by heat, do not keep or store the instrument or the accessories in such places.

Because of danger of short circuits instrument and accessories must not come in direct contact with fluids!
Instrument and accessories may be operated, kept and stored only in places where the environmental relative humidity is between 30 and 90 % (non-condensing).

Instrument and accessories are not acid resistant!
Make sure to avoid direct contact of acid or acid solutions with the instrument or the accessories.

Instrument and accessories must not be operated in an explosive atmosphere!

Instrument and accessories are to be protected against static charge! Electric discharges may delete internally stored data or damage internal components.

2.4 Opening the Instrument or Accessories

The battery is the only user-serviceable part of the instruments DELTASCOPE® MP10, ISOSCOPE® MP10 and DUALSCOPE® MP20 and the accessories.

To prevent damages to the internal components, the instrument or accessories should only be opened to replace the battery. Further servicing of the instrument or accessories should only be performed by Fischer authorized service technicians.

2.5 Handling the Probes

When measuring, the probe tips are placed directly on the measuring object. To reduce probe tip wear, keep the following in mind:

Place the probe rapidly, but gently on the surface of the measuring object! Avoid hard impacts!

Do not drag the probe tip(s) over the surface of the measuring object!

Do not place a standard probe on hot or acid-covered surfaces, do not submerse a standard probe into liquids!
Special probe types are available for these applications.
(→ "3.2 Probes", page 14)

2.6 Handling the Calibration Standards

Calibration standards in form of foils having various thicknesses are used to calibrate the measuring instruments DELTASCOPE® MP10, ISOSCOPE® MP10 and DUALSCOPE® MP20.
The good condition of the calibration standards is an important requirement for an accurate calibration and therefore for correct measurements.

To ensure the good condition of the calibration standards, keep the following in mind:

☛ To reduce the wear and tear of the calibration standards, the calibration standards should only be used for calibration purposes. Do not use them for test measurements!

☛ Do not soil, bend or scratch the calibration standards. Soiled, bent or scratched calibration standards or standards with deep gouges have to be replaced by new standards.
Especially foils less than 50 µm (2 mils) thick are subject to rapid wear! We recommend no more than 100 or 200 measurements before replacing such foils.

☛ To protect the calibration standards from dirt or damage, keep and store the standards in the supplied calibration standard case.

2.7 Warranty

Fischer will not be responsible or honor any warranty claims for the following cases:

- Misuse of the instrument or the accessories
- Improper use of the instrument or accessories (e. g. operating in an explosive, highly corrosive or excessively hot atmosphere)

3 Instrument and Accessories Description

3.1 DELTASCOPE® MP10, ISOSCOPE® MP10 and DUALSCOPE® MP20

The functions and the operation of the above instrument models are identical. The instruments only differ in the test method used, therefore in the measurement application capability and the probes, which can be used for measurement (see tables 3.1 and 3.2).

3.1.1 Measurement Application Capabilities and Test Methods

Instrument Model	Thickness Measurement of	Test Method
DELTASCOPE® MP10	Non-ferromagnetic or non-conductive coatings on steel or iron	Magnetic induction test method according to DIN EN ISO 2178, ASTM B499 or BS 5411/11
ISOSCOPE® MP10	Non-conductive coatings on non-ferromagnetic substrates	Eddy current test method according to DIN EN ISO 2360, ASTM B244 or BS 5411/3
DUALSCOPE® MP20	Non-ferromagnetic or non-conductive coatings on steel or iron	Magnetic induction test method according to DIN EN ISO 2178, ASTM B499 or BS 5411/11
	Non-conductive coatings on non-ferromagnetic substrates	Eddy current test method according to DIN EN ISO 2360, ASTM B244 or BS 5411/3

Table 3.1: Measurement Application Capability and Test Method

3.1.2 Front and Rear View

The marked or displayed instrument model is a difference between the front view of the instrument models DELTASCOPE® MP10, ISOSCOPE® MP10 and DUALSCOPE® MP20. Additionally, the key **FINAL-RES** is located on the keypad of the DUALSCOPE® MP20. The instruments MP10 do not have the key **FINAL-RES.**
The rear view of these instruments is identical.

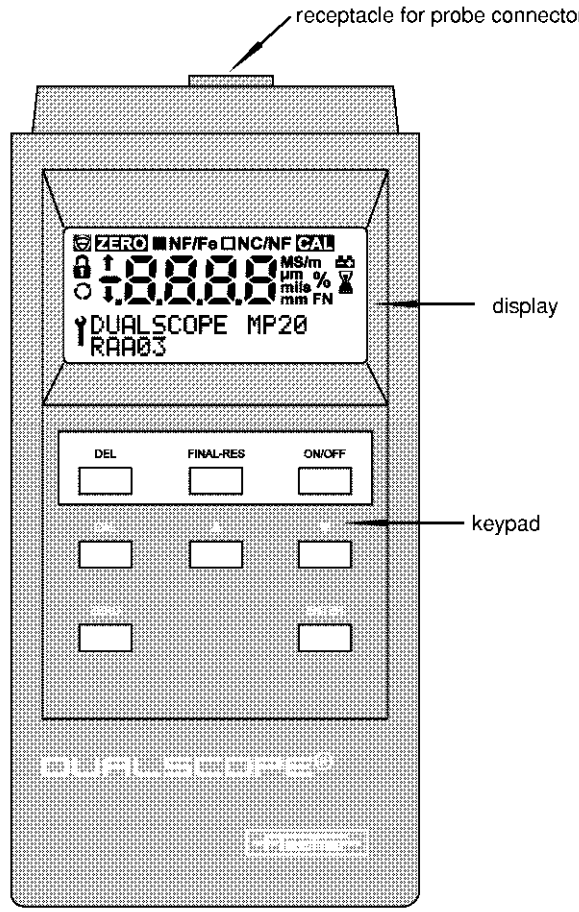


Figure 3.1: Front View of the DUALSCOPE® MP20

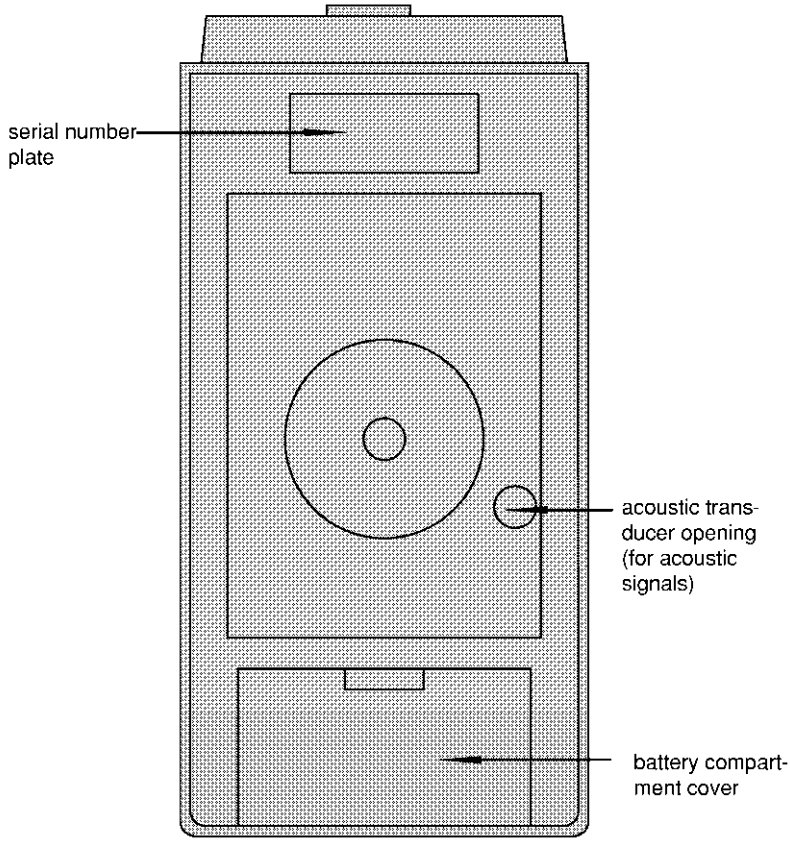


Figure 3.2: Rear View

3.1.3 Keypad Functions

The white and grey rectangles of the keypad are the actual membrane keys. Pressing and releasing a key produces a slight click. Pressing the text above the key instead of the key membrane will not actuate the key function.

The overview on the following pages contains a brief description of the individual keypad functions:

Key	Function
DEL	Delete the last measurement value (only with DUAL-SCOPE® MP20); 2x **DEL**: delete all measurement values (only with DUAL-SCOPE® MP20); during normalization: 1x **DEL** - delete the last measurement, 2x **DEL** - delete the measurement series taken on substrate material; during calibration: 1x **DEL** - delete the last measurement, 2x **DEL** - delete the measurement series taken on the current calibration standard, pressing **DEL** repeatedly - delete the measurement series taken on the previous calibration standards
FINAL-RES (only with MP20!)	Call-up the evaluation; pressing **FINAL-RES** repeatedly: display in sequence the evaluation parameters calculated from the measurements (mean value, standard deviation, etc); followed by **ENTER**: delete the stored measurements and end the display of the calculated parameters (return to measurement); followed by **DEL**: end the display of the calculated parameters (return to measurement) without deleting the stored measurements; during calibration and normalization: enabling and disabling the "continuous" display mode (display the normalized probe output signal of the measurement, measurements will not be stored and not be used for calibration or normalization purposes)

Key	Function
ON/OFF	Switch the instrument on and off; **ON/OFF + ▲**: switch the instrument on and enable the acoustic measurement accept signal (with the instrument switched off before); **ON/OFF + ▼**: switch the instrument on and disable the acoustic measurement accept signal (with the instrument switched off before); **ON/OFF + DEL**: switch the instrument on and enable the restricted operating mode (with the instrument switched off before); **ON/OFF + ENTER**: switch the instrument on and disable the restricted operating mode (with the instrument switched off before)
CAL	Call-up the corrective calibration; followed by **CAL**: cancel the corrective calibration; **CAL + DEL**: delete the corrective calibration
▲	Change the displayed numerical values or parameters during calibration or parameter entry (if ▲ is pressed for more than 3 seconds, the display will change faster)
▼	Enabling and disabling the "continuous" display mode; Change the displayed numerical values or parameters during calibration or parameter entry (if ▲ is pressed for more than 3 seconds, the display will change faster)
ZERO	Call-up the normalization
ENTER	Confirm the input; 10x **ENTER**: call-up the configuration programs

3.1.4 Display

The display consists of multiple segments and symbols. At power-up with **ON/OFF**, briefly all segments and symbols will appear simultaneously.

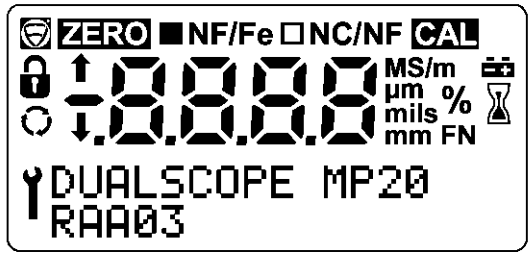


Figure 3.3: Display (Example)

Display element	Explanation
	Fischer trademark
ZERO	Indicates that a normalization is performed (on uncoated measuring object (= substrate material))
■ **NF/Fe**	Indicates that measurements using the magnetic induction test method are performed
□ **NC/NF**	Indicates that measurements using the eddy current test method are performed
CAL	Indicates that a calibration is performed
	Padlock: indicates that the restricted operating mode has been enabled, i. e. the keys **ZERO** and **CAL** are not active, it is not possible to call-up the configuration programs

Display element	Explanation
	Arrow-circle: indicates that the "continuous" display mode has been enabled resulting in continuous display of the measurements with placed probe
-8.8.8.8	Number elements to display the measurement values, error messages and warnings
MS/m µm % mils % mm FN	Unit of measurement of the displayed value
	Battery: indicates that the battery has to be changed or re-charged, because of low battery voltage
	Hour glass: indicates that the instrument is busy
	Wrench: indicates that the configuration programs have been called-up (the parameters of the individual configuration programs can be changed now)
DUALSCOPE MP20 RAA03	Prompt lines containing notes to guide the use [DELTASCOPE MP10], [ISOSCOPE MP10] or [DUALSCOPE MP20]: instrument model [RAA..]: instrument software version

3.2 Probes

All probes, which can be connected to the DELTASCOPE® MP10, ISOSCOPE® MP10 or DUALSCOPE® MP20, are equipped with a memory chip in the probe connector.
The description E... (e. g.: ED10) indicates the use of the memory chip (E stands for EEPROM).
The EEPROM stores all probe-specific information (e. g. probe type, manufacturing code, test method and the coefficients of the master calibration).

When switching the instrument ON, the instrument reads and processes the information of the connected probe automatically; the instrument "recognizes" the probe.

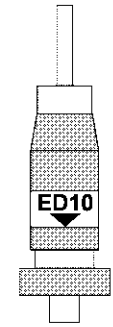


Figure 3.4:
Probe Connector
of a ED10 Probe

Correct coating thickness measurements can be performed only if a suitable probe is used for measurement application (see table 3.2).

Probe	DELTASCOPE® MP10	ISOSCOPE® MP10	DUALSCOPE® MP20
Magnetic Induction Probes	●		●
Eddy Current Probes		●	●
Dual Probes			●

● Probe is suitable for measurement

Table 3.2: Probes Suited for Measurement

The magnetic induction and eddy current test method are combined in dual probes. Non-ferromagnetic or non-conductive coatings on iron or steel as well as non-conductive coatings on non-ferromagnetic substrates can be measured with dual probes. The correct test method is selected automatically when placing the probe on the measuring object.
Dual probes are suited only for coating thickness measurement with the DUALSCOPE® MP20.

Several different probe types are available for measurements on objects having complex shapes and different surface structures. Special probe types with different measurement ranges are available for the following applications:

- extremely rough surfaces
- extremely soft or hard surfaces
- wet or acid-covered surfaces
- extremely thick or thin coatings
- hot surfaces
- coatings inside of pipes

For information on the available probes, or advise regarding probes best suited to your applications, please refer to the brochure "Probes and Measurement Fixtures - Application Specific Probes - The key to successful coating measurement". This brochure is available from Fischer or your nearest Fischer sales representative.

3.3 Calibration Standards

For calibration purposes, the calibration standards (in form of foils or shims having various thicknesses) are placed on the uncoated measuring object to simulate the coating to be measured.

Every probe type has a probe-specific set of calibration standards for the master calibration (master foils) and a probe-specific set of calibration standards for the corrective calibration (corrective foils), which have been prepared specifically for this probe type.

The probe-specific calibration standards and additional calibration standards are available on request.

The thickness of the calibration standards (calibration foils) is measured by Fischer with a mechanical indicator gauge.
The indicated tolerance refers only to the area within the circle (see figures 3.5 and 3.6).

- The thickness of CuBe foils can be measured only with the magnetic induction test method, because Copper Beryllium is a conductive material. For this reason, CuBe foils are to be used only to calibrate magnetic induction probes or the magnetic induction channel of dual probes.
- Only CuBe foils should be used at thicckneses below 30 µm (1.2 mils) for the calibration of magnetic induction probes or the magnetic induction channel of dual probes. CuBe foils are not subject to the fairly high indentation error of plastic foils.
- When measuring the thickness of foils having the same thickness, but of different materials (e. g. a 12 µm CuBe foil and a 12 µm plastic foil), on a rough surface, the thicknesses measured on the two foils may differ greatly. This difference is caused by the greater hardness of the CuBe foil. (The hard CuBe foil lies on the peaks of the rough surface, whereas the smooth plastic foils are pressed into the rough surface by the pressure of the probe tip.
  For this reason, the same foil material should be used for test measurements, which was used for calibration!

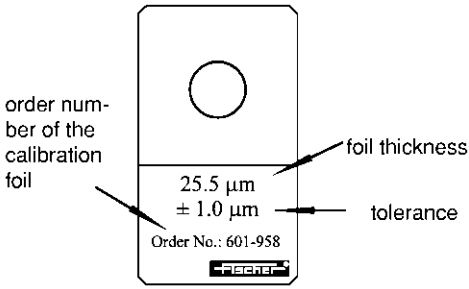


Figure 3.5: Calibration Foil (Example)

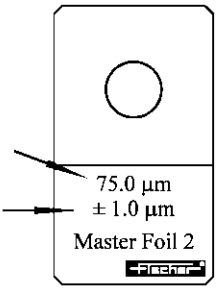


Figure 3.6: Master Foil (Example)

4 Switching the Instrument ON and OFF

4.1 Switching the Instrument ON

☛ **To avoid erroneous measurements, keep the probe tip(s) at least 50 mm (2 ") away from any metal object when switching the instrument ON!**

☛ Depending on the selected display mode, a coating thickness measurement value, a probe output siganl or a normalized probe output signal is displayed after switching the instrument on.
(Selecting the display mode: ➙ "8.3.5 Configuration Program ZERO", page 54)

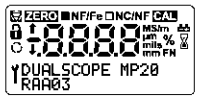
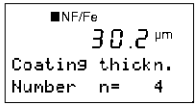
☛ If [E 0 2 2 - Missing Probe !] appears briefly when switching the instrument on, there is no probe connected to the instrument, the probe is not connected correctly or the connected probe is defective. Measurements are not possible without a probe connected. (Connecting a probe: ➙ "7.3 Connecting or Replacing a Probe", page 45)

4.1.1 Test Method of the Connected Probe

After switching the instrument ON, the test method of the currently connected probe will be displayed.

Display	Explanation
[■NF/Fe]	Magnetic induction probe connected
[□NC/NF]	Eddy current probe connected
[NF/Fe NC/NF]	Dual probe connected

Switching the Instrument ON:

Keys	Detail of the Display	Explanation
ON/OFF		Press key **ON/OFF** to switch the instrument on. An acoustic signal will sound. The instruments performs an automatic power-up selftest. All display elements appear briefly. [DUALSCOPE MP20] or [DELTASCOPE MP10] or [ISOSCOPE MP10]: instrument model [RAA..]: instrument software version
		Following that, ⌛ appears briefly.
		Following the power-up selftest, the instrument is ready to measure. [■NF/Fe] or [□NC/NF] or [NF/Fe NC/NF]: test method of the currently connected probe (→ page 17) [µm] or [mils] or [mm]: unit of measurement of the displayed value [Appl:]: number of the current application [Coating thickn.]: coating thickness measurement values are displayed (display mode: → page 19) [Number n=]: number of measurement values stored (displayed only with the DUALSCOPE® MP20)

4.1.2 Display Modes

The following display modes can be selected according to table 4.1 (selecting the display mode: ➙ "8.3.5 Configuration Program ZERO", page 54):

- Display Coating Thickness
- Display Xn and Xs
- Display th and Xs
- Display Countrate
- Display Normalized Countrate

Display Mode	Detail of the Display (with Measurement)	Explanation
Coating thickn.	205 µm Coating thickn.	Display of the coating thickness measurement value th
Xn and Xs	.5378 Xs= 42370	Display of the measured normalized probe output signal Xn [Xs=]: saturation countrate Xs
th and Xs	205 µm Xs= 42370	Display of the coating thickness measurement value th [Xs=]: saturation countrate Xs
Countrate	4538 X= 45380	Display of the first four figures of the measured probe output signal X [X=]: countrate X (all figures)
norm. Countrate	.7834	Display of the measured normalized probe output signal Xn

Table 4.1: Display Modes (Overview) (with Exemplary Display)

4.2 Switching the Instrument OFF

The instrument will switch itself off automatically if no measurement is taken and no key is pressed for approximately three minutes.
However, if the auto switch-off mode has been disabled in the configuration programs, the instrument will not switch itself off automatically.
(Disable the auto switch-off mode with MP10: → "8.3.5 Configuration Program ZERO", page 54; disable the auto switch-off mode with MP20: → "8.3.1 Configuration Program FINAL-RES", page 51)

To switch the instrument off manually simply press the **ON/OFF** key. The display will go blank.

5 Measurement and Evaluation

5.1 Measurement

☛ It is absolutely necessary to follow the instructions of the chapter "2 Notes Concerning the Operation of the Instruments and Handling the Accessories" (from page 3)!

5.1.1 Preparations for Measurement

The instrument and the measuring area of the measuring object have to be prepared for measurement as follows:

- Determination of the significant surfaces and the reference areas according to / 6 /.
- Making sure, that the reference area is not damaged and clean (e. g. free of fluids, dirt or grease).
- Perform the instrument start-up (→ "7.1 Instrument Start-Up", from page 43).
- Switch the instrument on (→ "4.1.1 Switching the Instrument ON", from page 18).
- Check the normalization and calibration by reference measurement on an object having known coating thickness (→ "6.1 Reference Measurement", page 30).
- Definition of the instrument configuration (→ "8 Instrument Configuration", from page 47).

5.1.2 Making a Measurement

The probe has to be placed vertically on the surface of the measuring object to perform a measurement. The measurements should be performed within the reference area.
Following the measurement accept, i. e. after the measurement appears in the display, the probe can be lifted again. The instrument is ready to measure again.

Figure 5.1: Display with Measurement
(taken with the eddy current channel of a dual probe)

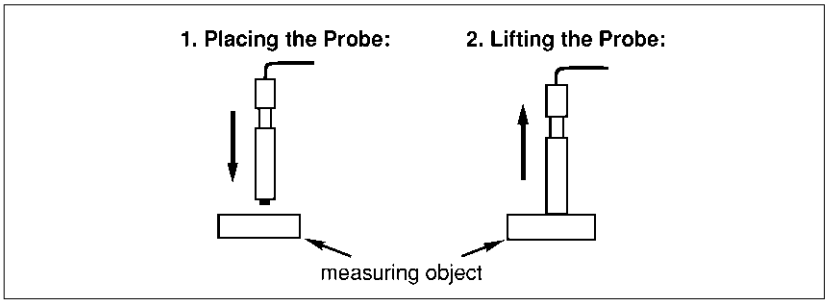


Figure 5.2: Measurement with Axial Single Tip Probes

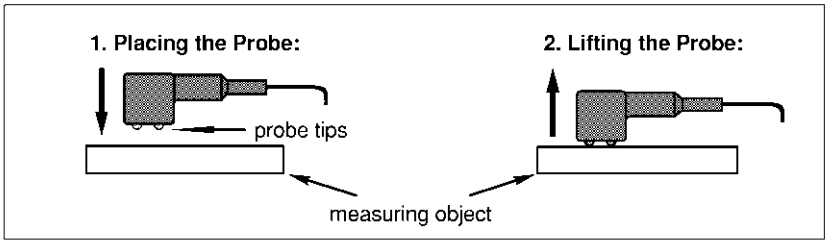


Figure 5.3: Measurement with Double Tip Probes

☛ With automatic measurement accept enabled, the probe has to be lifted at least 50 mm (2 ") from the measuring object between readings.

☛ To avoid erroneous measurements, do not hover above the measuring object with the probe!

It is necessary to note the following when measuring with double tip probes (see figure 5.3):

- When measuring on cylindrical objects, the probe tips should be placed in line with the longitudinal axis of the cylindrical object!
- Both tips should be placed simultaneously and with equal pressure!
- We recommend to measure coatings of measuring objects with substrate materials having a magnetic preference direction by storing the mean value of two measurements instead of the single measurements. The probe has to be turned by 90° after the first measurement (see figure 5.4). Magnetic preference direction can result from mechanical pretreatment of the measuring object (for instance, rolling or drawing of sheet metal).

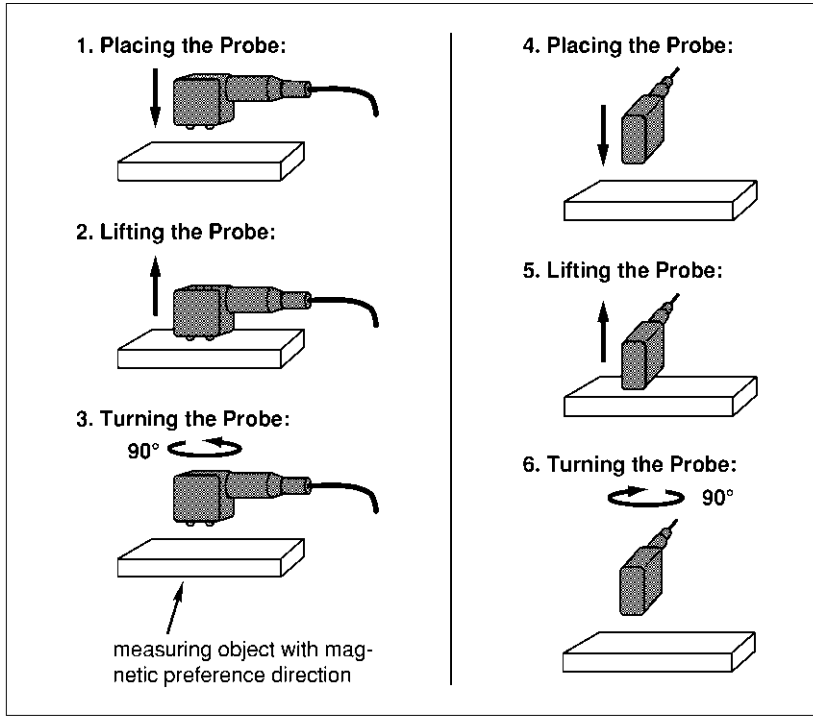


Figure 5.4: Measurement with Double Tip Probes
on Measuring Objects with Magnetic Preference Direction

5.1.3 Measurement Accept

With automatic measurement accept enabled, the measurement will be accepted immediately after placing the probe on the measuring object.
An acoustic signal will sound with every measurement taken (unless it is disabled) after measurement accept. The signal indicates that the measurement signal coming from the probe is captured and the probe may be lifted off from the measuring object again.
(Enable and disable the acoustic measurement accept signal: ➙ "8.1 Acoustic Measurement Accept Signal", page 47)

With "continuous" display mode enabled (enabling on the "continuous" display mode: ➙ "5.1.6 Measurement with "Continuous" Display Mode", page 25), measurement accept can be initiated by:

- pressing the key **ENTER**

5.1.4 Display of the Test Method Used when Measuring with Dual Probes

The test method of the connected probe appears in the upper line of the display after switching the instrument on (➙ "4.1.1 Test Method of the Connected Probe", page 17).
With dual probes, the test method used for the last measurement will be indicated after measurement accept.

Display	Explanation
[■NF/Fe NC/NF]	Measurement using the magnetic induction test method was performed
[NF/Fe □NC/NF]	Measurement using the eddy current test method was performed

5.1.5 Deleting Erroneous Measurements

If an erroneous measurement is recognized immediately after measurement accept, the measurement can be deleted by pressing the **DEL** key once.
All measurements can be deleted by pressing **DEL** twice.

5.1.6 Measurement with "Continuous" Display Mode

With the "continuous" display mode enabled, you can easily determine the coating thickness distribution over the surface of the measuring object by moving the placed probe over the surface.
With "continuous" display mode enabled,

- measurements will be displayed continuously and
- measurements will not be accepted or stored automatically.

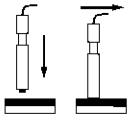
When moving the placed probe over a test surface, the probe tip(s) are subject to increased wear and tear!

☛ As long as the "continuous" display mode is enabled, measurement accept can be initiated only by pressing **ENTER**.

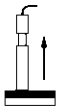
☛ The "continuous" display mode will be disabled automatically when switching the instrument off!

Measurement with "Continuous" Display Mode Enabled:

Keys / Actions	Detail of the Display	Explanation
▼	○ - - - - - Coating thickn.	Press the key ▼ to enable the "continuous" display mode. ☛ As long as the "continuous" display mode is enabled, ○ appears in the display.



Place the probe on the measuring object and move the probe over the surface of the object to determine the coating thickness distribution.



Lift off the probe from the measuring object.

▼

Press the key ▼ again to disable the "continuous" display mode.

5.2 Evaluation (only with DUALSCOPE® MP20)

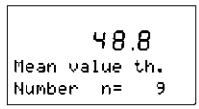
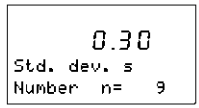
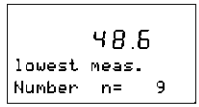
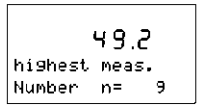
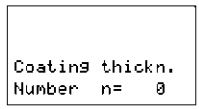
☛ An evaluation can only be performed with the DUALSCOPE® MP20! It is not possible to perform an evaluation with the DELTASCOPE® MP10 or ISOSCOPE® MP10!

When performing an evaluation, the following parameters are calculated from the measurements and can be displayed in succession:

- mean value
- number of the measurements evaluated
- standard deviation
- lowest and highest measurement

☛ Detailed explanations about the evaluation parameters can be found in chapter "11 Glossary of Terms and Symbols" (from page 73).

Evaluation (with the Instrument Switched ON):

Keys	Detail of the Display	Explanation
FINAL-RES		Call-up the evaluation with the key **FINAL-RES**. [Mean value th.]: mean value th. is displayed [n=]: number of measurements evaluated
FINAL-RES		Display the next calculated parameter with **FINAL-RES**. [Std. dev. s]: standard deviation s is displayed [n=]: number of measurements evaluated
FINAL-RES		Display the next calculated parameter with **FINAL-RES**. [lowest meas.]: lowest measurement is displayed [n=]: number of measurements evaluated
FINAL-RES		Display the next calculated parameter with **FINAL-RES**. [highest meas.]: highest measurement is displayed [n=]: number of measurements evaluated
ENTER		Terminate the evaluation and delete the stored measurements with **ENTER**. If ▲ is pressed instead of **ENTER**, the evaluation will be terminated without deleting the stored measurements. The instrument is ready to measure again. Further explanations concerning the display: ➞ "4.1.1 Switching the Instrument ON", page 18.

For Your Notes.

6 Normalization and Calibration

The following factors affect the coating thickness measurement:

- geometry of the measuring object (size of the reference area, curvature, substrate thickness)
- magnetic permeability or electrical conductivity of the measuring object

The effects of these factors can be corrected for by normalization or calibration.

A **normalization** (measurement on an uncoated measuring object) is sufficient whenever the a. m. properties of the measuring object change only slightly.
If changes in geometry, magnetic permeability, or electrical conductivity are significant and cannot be compensated by a normalization, a **corrective calibration** becomes necessary.
If the changes of the a. m. factors are very significant, a **master calibration** has to be performed.

☛ For the normalization, corrective calibration and master calibration, an uncoated measuring object of the same material and geometry as the coated objects to be measured is absolutely essential!
Do not use the supplied test piece (Fe- or Al-Base) for a normalization or calibration, because its material characteristics may differ from those of the measuring object! (The test piece should be used for functional testing only.)

☛ To ensure the measurement accuracy specified for the probe connected, it is absolutely necessary to perform each normalization and calibration very carefully.

☛ It is absolutely necessary to follow the instructions of chapter "2 Notes Concerning the Operation of the Instruments and Handling the Accessories" (from page 3)!

☛ CuBe calibration standards are to be used only to calibrate magnetic induction probes or the magnetic induction channel of dual probes (➙ "3.3 Calibration Standards", from page 15).

☛ Perform reference measurements after each normalization and calibration to check the normalization or calibration!

☛ Following a normalization or calibration with the DUALSCOPE® MP20 all measurements will be deleted.

☛ With the restricted operating mode enabled (indicated by 🔒 in the display) it is not possible to start a normalization or calibration!

☛ When normalizing or calibrating with a dual probe, the first measurement performed for this normalization or calibration will determine the channel of the dual probe, which will be normalized or calibrated.
If the first measurement for a normalization is performed on a ferromagnetic measuring object, for example, the magnetic induction channel of the dual probe will be normalized.

☛ Performing a normalization or calibration with a dual probe will normalize or calibrate the application only for one test method at first. The normalization or calibration for the other test method also has to be performed, so that coating thicknesses can be measured correctly with both test methods.

6.1 Reference Measurement

When performing a reference measurement, measurements are taken on a reference sample. If the deviations of these measurements from the coating thickness of the reference sample violate the specified tolerances, the normalization or calibration has to be performed again.

A reference measurement requires:

- reference sample (coated measuring object with known coating thickness and of the same geometry and of the same substrate material as the coated objects to be measured)

☛ Reference samples are subject to wear and tear caused by the tactile measurement. Reference samples have to be checked regularly and replaced by new reference samples if the wear and tear becomes significant.

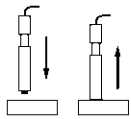
6.2 Normalization

During a normalization, a new zero point will be determined for the calibration curve and stored in the EEPROM memory chip of the probe connector.

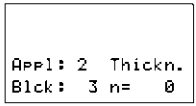
A normalization requires:

- uncoated measuring object of the same geometry and of the same substrate material as the coated objects to be measured

Normalization (with the Instrument Switched on):

Keys / Actions	Detail of the Display	Explanation
ZERO	ZERO 0.00 Base Cancel: ENTER	Call-up normalization with **ZERO**. ZERO appears and remains in the display as long as the normalization is performed. [Base]: measurements have to be performed on the uncoated measuring object (substrate material) [Cancel: ENTER]: press **ENTER** to cancel the normalization
 SM	ZERO 0.02 s= 0.01 n= 5 OK: ENTER Delete: DEL	Perform a measurement on the uncoated measuring object (substrate material). Repeat the measurement at several points of the reference area until the mean value is stable (or the change of the mean value after another measurement does not violate the admissible limit for this change). The mean value of all normalization measurements will be displayed. [s= 0.01 n= 5]: standard deviation s=0.01, number of measurements n=5 [OK: ENTER]: press **ENTER** to confirm and end the normalization [Delete: DEL]: press **DEL** to delete the last measurement, 2x **DEL** deletes all normalization measurements

ENTER



Confirm and end the normalization with **ENTER**. The new calibration parameters will be determined and stored automatically. The instrument is ready to use now. (Further explanations concerning the display: ➞ "4.1.1 Switching the Instrument ON", from page 18.)
Perform reference measurements to check the normalization!

6.3 Corrective Calibration

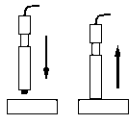
During a corrective calibration, a new zero point and one additional point (one-point calibration with one calibration standard) or two additonal points (two-point calibration with two calibration standards) will be determined to adjust the calibration to the measuring object. The new calibration parameters will be determined and stored in the EEPROM memory chip of the probe connector.

A corrective calibration requires:

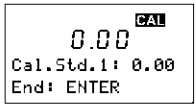
- uncoated measuring object of the same geometry and of the same substrate material as the coated objects to be measured
- calibration standard(s) for the corrective calibration (probe-specific corrective foil(s))

The corrective calibration using the corrective foils supplied with the probe offers the best measurement accuracy for the entire measurement range of the probe.
To increase the accuracy at a specific narrow thickness range, a foil with a thickness covered by this range can be used. However, this usually reduces the accuracy outside this range when compared to the corrective calibration performed with the supplied probe-specific corrective foils.

Corrective Calibration (with the Instrument Switched on):

Keys / Actions	Detail of the Display	Explanation
CAL	CAL 0.00 Base Skip: ENTER Cancel: CAL Delete cal.: DEL	Call-up the corrective calibration with **CAL**. CAL appears and remains in the display as long as the corrective calibration is performed. [Base]: measurements have to be performed on the uncoated measuring object (normalization) [Skip: ENTER]: press **ENTER** to skip the normalization (stored normalization will not be changed) [Cancel: CAL]: press **CAL** to cancel the corrective calibration [Delete cal.: DEL]: press **DEL** to delete the corrective calibration of the current application (→ page 36)
 SM	CAL 0.02 s= 0.01 n= 5 OK: ENTER Delete: DEL	Perform a measurement on the uncoated measuring object (substrate material). Repeat the measurement at several points of the reference area until the mean value is stable (or the change of the mean value after another measurement does not violate the admissible limit for this change). The mean value of all normalization measurements will be displayed. [s= 0.01 n= 5]: standard deviation s=0.01, number of measurements n=5 [OK: ENTER]: press **ENTER** to confirm the normalization [Delete: DEL]: press **DEL** to delete the last measurement, 2x **DEL** deletes all normalization measurements

ENTER

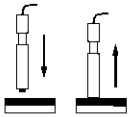


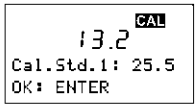
Confirm and store the normalization with **ENTER**. (Previous normalization will be overwritten.)

[End: ENTER]: press **ENTER** to confirm and end the corrective calibration at this point

[Back: DEL]: press **DEL** to go back to the normalization

[Entry: ▲▼]: use the arrow keys to enter the thickness of the corrective foil


SM + Foil



Place the first calibration standard (corrective foil) on the uncoated measuring object and perform a measurement.
Repeat the measurement at several points of the reference area until the mean value is stable (or the change of the mean value after another measurement does not violate the admissible limit for this change). The mean value of all measurements performed for this calibration step will be displayed.

[Cal.Std.1:]: foil thickness stored for the first calibration standard

[OK: ENTER]: press **ENTER** to confirm and end the current calibration step

[Delete: DEL]: press **DEL** to delete the last measurement, 2x **DEL** deletes the whole measurement series (all measurements performed for this calibration step), press 3x **DEL** to go back to the previous calibration step

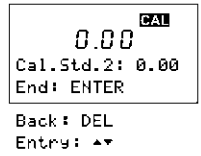
[Entry: ▲▼]: use the arrow keys to enter the thickness of the corrective foil

▲, ▼

Use the arrow keys to set the displayed value to the current foil thickness (this step is not required, if the displayed foil thickness corresponds to the current foil thickness of the corrective foil).

[OK: ENTER]: press **ENTER** to confirm and end the current calibration step

ENTER



If a corrective calibration with two calibration standards is desired: proceed for the second calibration standard (corrective foil) in the same manner as described above for the first calibration standard.
Otherwise: press **ENTER** to confirm and end the corrective calibration.

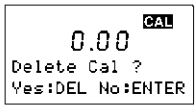
ENTER

Press **ENTER** to confirm and end the last calibration step. The new calibration parameters will be determined and stored automatically.
The instrument is ready to use now.
(Further explanations concerning the display: → "4.1.1 Switching the Instrument ON", from page 18.)
Perform reference measurements to check the corrective calibration!

6.3.1 Deleting the Corrective Calibration

☛ When deleting the corrective calibration of a dual probe, the corrective calibration of both channels (magnetic induction and eddy current) will be deleted.

Deleting the Corrective Calibration (with the Instrument Switched on):

Keys	Detail of the Display	Explanation
CAL	 Cancel: CAL Delete cal.: DEL	Call-up the corrective calibration with **CAL**. [Cancel: CAL]: press **CAL** to cancel the corrective calibration [Delete cal.: DEL]: press **DEL** to delete the corrective calibration
DEL		Delete the corrective calibration with **DEL**. [Yes:DEL No:ENTER]: press **DEL** to delete the corrective calibration; press **ENTER** to cancel the procedure and keep the corrective calibration stored
DEL		Confirm the deleting of the corrective calibration with **DEL**. The corrective calibration will be deleted. The instrument is ready to measure now.

6.4 Master Calibration

During a master calibration the coefficients of the master calibration are determined and stored in the EEPROM memory chip of the probe connector. These coefficients define the relationship between probe signal and coating thickness.

The probes delivered from Fischer are already master calibrated. The coefficients of this master calibration (computed during the master calibration, which was performed at Fischer) are stored in the EEPROM memory chip of the probe connector. These coefficients will be overwritten when performing a new master calibration.

A master calibration requires:

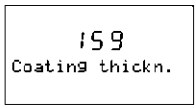
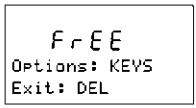
- uncoated measuring object of the same geometry and of the same substrate material as the coated objects to be measured
- probe-specific set of calibration standards (master foils)

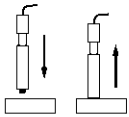
☛ A master calibration should be performed only by an experienced user of the instrument!

☛ To ensure the measurement accuracy specified for the probe connected, it is absolutely necessary to use the probe-specific set of master foils for the master calibration.

☛ After a complete master calibration, the normalization and corrective calibration, which have been stored in the connected probe, will be deleted automatically.
After performing a master calibration with dual probes, the normalization and corrective calibration of both channels (magnetic induction and eddy current) will be deleted.
A new normalization or corrective calibration has to be performed if required!

Master Calibration (with the Instrument Switched on):

Keys / Actions	Detail of the Display	Explanation
10 x ENTER		Call-up the configuration programs by pressing **ENTER** 10 times.
2 x ▲		Set the display to the code number of the configuration programs. [159]: Code number of the configuration programs
ENTER		Confirm with **ENTER**. [Options: KEYS]: The desired configuration program can be selected by pressing the corresponding key [Exit: DEL]: Configuration programs can be exited by pressing **DEL**
CAL	 Cancel: CAL	Call-up the master calibration by pressing **CAL**. **ZERO** and **CAL** appear and remain in the display as long as the master calibration is performed. [Master Cal. Base]: master calibration has been called-up; measurements have to be performed on the uncoated measuring object (substrate material) (normalization) [Skip: ENTER]: press **ENTER** to skip the normalization (stored normalization will not be changed) [Cancel: CAL]: press **CAL** to cancel the master calibration



ZERO CAL
0.02
s= 0.01 n= 5
OK: ENTER
Delete: DEL

Perform a measurement on the uncoated measuring object (substrate material). Repeat the measurement at several points of the reference area until the mean value is stable (or the change of the mean value after another measurement does not violate the admissible limit for this change). The mean value of all normalization measurements will be displayed.

[s= 0.01 n= 5]: standard deviation s=0.01, number of measurements n=5

[OK: ENTER]: press **ENTER** to confirm and end the normalization

[Delete: DEL]: press **DEL** to delete the last measurement, 2x **DEL** deletes all normalization measurements

ENTER

ZERO CAL
0.00
Cal.Std.1: 13.5
Cancel: ENTER
Back: DEL
Entry: ▲▼

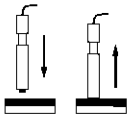
Confirm and store the normalization with **ENTER.** The previous normalization will be overwritten.

[Cal.Std.:]: foil thickness stored for the calibration standard

[Cancel: ENTER]: press **ENTER** to cancel the master calibration

[Back: DEL]: press **DEL** to go back to the normalization

[Entry: ▲▼]: use the arrow keys to enter the thickness of the master foil



ZERO CAL
13.2
Cal.Std.1: 13.5
OK: ENTER

Delete: DEL
Entry: ▲▼

Place the first calibration standard (master foil) on the uncoated measuring object and perform a measurement.
Repeat the measurement at several points of the reference area until the mean value is stable (or the change of the mean value after another measurement does not violate the admissible limit for this change).
The mean value of all measurements performed for this calibration step will be displayed.

[Cal.Std.1:]: foil thickness stored for the first calibration standard

[OK: ENTER]: press **ENTER** to confirm and end the current calibration step

[Delete: DEL]: press **DEL** to delete the last measurement, 2x **DEL** deletes the whole measurement series (all measurements performed for this calibration step), press 3x **DEL** to go back to the previous calibration step

[Entry: ▲▼]: use the arrow keys to enter the thickness of the master foil

▲, ▼

ZERO CAL
13.5
Cal.Std.1: 13.5
OK: ENTER

Delete: DEL
Entry: ▲▼

Use the arrow keys to set the displayed value to the current foil thickness (this step is not required, if the displayed foil thickness corresponds to the current foil thickness of the master foil).

[OK: ENTER]: press **ENTER** to confirm and end the current calibration step

ENTER

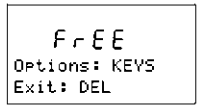
ZERO CAL
0.00
Cal.Std.2: 55.5
Cancel: ENTER

Back: DEL
Entry: ▲▼

Proceed for the second calibration standard in the same manner as described above for the first calibration standard.
Proceed in the same manner for the third and fourth calibration standard.

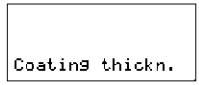
ENTER

Press **ENTER** to confirm and end the last calibration step. ⌶ appears briefly in the display.
The new master calibration parameters will be determined and stored automatically.



[FrEE] is displayed automatically.
[Options: KEYS]: The desired configuration program can be selected by pressing the corresponding key
[Exit: DEL]: Configuration programs can be exited by pressing **DEL**

DEL



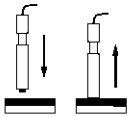
Exit the configuration programs by pressing **DEL**. The instrument is ready to use now.
(Further explanations concerning the display: ➞ "4.1.1 Switching the Instrument ON", from page 18.)
Perform reference measurements to check the master calibration!

6.5 Determination of the Normalized Probe Output Signal Xn of a Calibration Standard during Calibration (only with the DUALSCOPE® MP20)

During calibration, the normalized probe output signal Xn of a calibration standard can be determined as described below without interference with the calibration.

☛ The normalized probe output signal of a calibration standard can be determined during calibration only with the DUALSCOPE® MP20!

Determining Xn of a Calibration Standard during Calibration:

Keys / Actions	Detail of the Display	Explanation
FINAL-RES	CAL 0 1.000 Free disp. mode off: FINAL-RES	Press **FINAL-RES** to enable the "continuous" display mode during calibration. [Free disp. mode off: FINAL-RES]: press **FINAL-RES** to disable the "continuous" display mode again
 SM + Foil	CAL 0 0.130 Free disp. mode off: FINAL-RES	To determine the normalized probe output signal Xn of a calibration standard, place the probe on the standard. The normalized probe output signal Xn will be displayed. (The normalized probe output signal will not be stored!) [Free disp. mode off: FINAL-RES]: press **FINAL-RES** to disable the "continuous" display mode again
FINAL-RES		Disable the "continuous" display mode by pressing **FINAL-RES**. The interrupted calibration can be continued.

7 Instrument Start-Up, Maintenance and Cleaning

To prevent electrical discharges, switch the instrument off before connecting or replacing a probe! Switch the instrument off before installing or replacing a battery!
Even small electrical discharges may delete internally stored data.

To prevent damage to the connector pins do not tilt the plug when inserting or disconnecting it.

☛ It is absolutely necessary to follow the instructions of chapter "2 Notes Concerning the Operation of the Instruments and Handling the Accessories" (from page 3)!

7.1 Instrument Start-Up

An instrument start-up includes the following steps:

- providing power for the instrument
  (→ "7.2 Power Supply", page 43)
- connecting a probe to the instrument
  (→ "7.3 Connecting or Replacing a Probe", page 45)

7.2 Power Supply

There are two ways to provide power for the instrument:

- 9 V battery
- rechargeable 9 V NiCd battery

☛ If appears in the display, the battery is discharged and needs to be replaced or recharged!

Installing or Replacing the Battery:

1. Switch the instrument off using **ON/OFF** (if it isn't off already).
2. Place the instrument with the back side facing up on a table. To open the battery compartment cover, insert the tip of a screwdriver into the slotted recess of the battery compartment cover and carefully push the screwdriver down (see figure 7.1). The cover will lift up on the side with the recess.

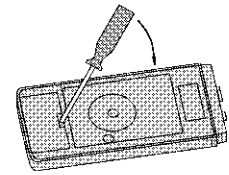


Figure 7.1: Open the Battery Compartment Cover

When handling the screwdriver take care not to injure yourself or other people with the screwdriver (e. g. because the screwdriver slipped at trying to open the battery compartment cover)!

3. Remove the battery compartment cover.
4. If an old battery has to be replaced, remove the old battery from the instrument and pull the battery connector clips from the contacts of the battery.

   Otherwise: Install the new battery as described in step 5.

   ☛ Exhausted or defective batteries are hazardous waste. Please observe your local waste disposal ordinances!

5. Connect the new battery by snapping the battery clips onto the contacts of the new battery. The shape of the clips prevents connecting the battery in reverse polarity.

Be careful not to touch the battery terminals to the battery connector clips with reverse polarity.

6. Put the battery back into its compartment. Close the battery compartment cover.

   ☛ Ensure that the battery clip wires are completely within the compartment so that the compartment can be closed correctly.

7.3 Connecting or Replacing a Probe

To prevent damage to the connector pins of the probe receptacle do not rotate the probe connector in the probe receptacle.

Connecting or Replacing a Probe:

1. Switch the instrument off with **ON/OFF** (if it isn't off already).
2. If the probe connected to the instrument needs to be replaced, unscrew the knurled locking ring completely. Carefully pull the the probe connector from the probe receptacle of the instrument.
   If no probe is connected to the instrument, continue with step 3.
3. Plug the probe connector of the new probe into the probe receptacle of the instrument (refer to figure 7.3).

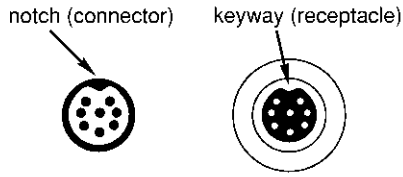


Figure 7.2: Probe Connector and Probe Receptacle

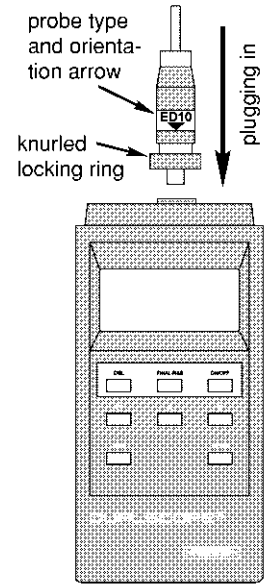


Figure 7.3: Orientation of the Probe Connector when Plugging the Probe Connector in the Probe Receptacle

To prevent wrong connection of probe and instrument or damage to the pins of the probe connector, do not try to plug in the probe connector unless keyway and notch are properly aligned (see figure 7.2)!

4. To prevent unintentional turning of the probe connector, keep hold of the probe connector when tightening the knurled locking ring.

   To prevent damage to the connector pins of the probe receptacle turn only the knurled lockIng ring. Do not rotate the probe connector in the probe receptacle!

5. Switch the instrument on with **ON/OFF**.
   The instrument recognizes automatically the type of probe connected.
   Check the normalization and calibration, which are stored in the EEPROM memory chip of the probe connector, by reference measurements on objects with known coating thickness (→ "6.1 Reference Measurement", page 30).

7.4 Cleaning

Should the instrument or the accessories get dirty, clean them with a cleaner suited for plastics and a soft cloth.

When cleaning observe the following:

- Switch the instrument off before cleaning it.
- Wipe off dirt immediately before it gets a chance to adhere to the surface!

Do not use aggressive cleaners that may blemish the plastic housing!

To prevent the instrument or the accessories from damage, do not clean them by scraping off the dirt, especially not near the probe tip(s).

Prevent water or any other liquid from entering the instrument or the accessories! (Danger of short circuits!)
Do not immerse the instrument or the accessories into liquids to remove dirt by soaking!
Do not pour any liquids over the instrument!

8 Instrument Configuration

Certain instrument settings, i. e. the unit of measurement or the display resolution, can be changed as required.

8.1 Acoustic Measurement Accept Signal

The acoustic measurement accept signal, i. e. the acoustic signal that sounds after each measurement, can be disabled.

8.1.1 Enabling the Acoustic Measurement Accept Signal

To enable the acoustic measurement accept signal after the instrument has been switched off, switch the instrument on using the key **ON/OFF** immediately followed by the key ▲.

☛ The acoustic measurement accept signal remains enabled unless it will be disabled again. It is not necessary to enable the acoustic measurement accept signal each time, the instrument is switched on.

8.1.2 Disabling the Acoustic Measurement Accept Signal

Pressing the key ▼ immediately after switching the instrument on using **ON/OFF** will disable the acoustic measurement accept signal, i. e. the acoustic measurement accept signal will no longer sound from then on.

☛ The acoustic measurement accept signal remains disabled unless it will be enabled again. It is not necessary to disable the acoustic measurement accept signal each time, the instrument is switched on.

8.2 Restricted Operating Mode

With the restricted operating mode enabled, only those keys necessary for measurement and evaluation are active. This may prevent erroneous measurements due to unintentional changes to the instrument parameters.
With the restricted operating mode enabled, the following keys are deactivated:

- **ZERO**
- **CAL**

Pressing these keys will not trigger any action, the display will not change. In addition, it is not possible to call-up the configuration programs!

8.2.1 Enabling and Disabling the Restricted Operating Mode

To enable the restricted operating mode with the instrument switched off, switch the instrument on using the key **ON/OFF** immediately followed by the key **DEL**.

☛ As long as the restricted operating mode is enabled, 🔒 appears in the display.

The restricted operating mode remains enabled unless it will be disabled. It is not necessary to enable the restricted operating mode each time, the instrument is switched on.

Pressing the key **ENTER** immediately after switching the instrument on using the key **ON/OFF** will disable the restricted operating mode again.

8.3 Configuration Programs

To change the parameters defined in the configuration programs, you need to call-up the configuration programs, select the desired configuration program by pressing the corresponding key, step through the individual parameter positions by pressing **ENTER**, and make the changes where desired. Using the arrow keys, the parameters can be changed.

☛ As long as the restricted operating mode is enabled (indicated by 🔒 in the display), it is not possible to call-up the configuration programs!

Call-up the Configuration Programs:

Keys	Explanation
10 x ENTER	Call-up the configuration programs by pressing **ENTER** 10 times (with the instrument switched on). [157] appears in the display.
2 x ▲	Set the display to [159] by pressing ▲.
ENTER	Confirm with **ENTER**. [FrEE] appears in the display. The desired configuration program can be selected by pressing the corresponding key.

☛ As long as the configuration programs are called-up, ↑ appears in the display.

☛ The following description of the configuration programs is based on the assumption that the configuration programs are called-up and have not yet been exited.

Exit the Configuration Programs:

Keys	Explanation
DEL	If [FrEE] appears in the display, the configuration programs can be exited by pressing **DEL**. The instrument is ready to measure again.

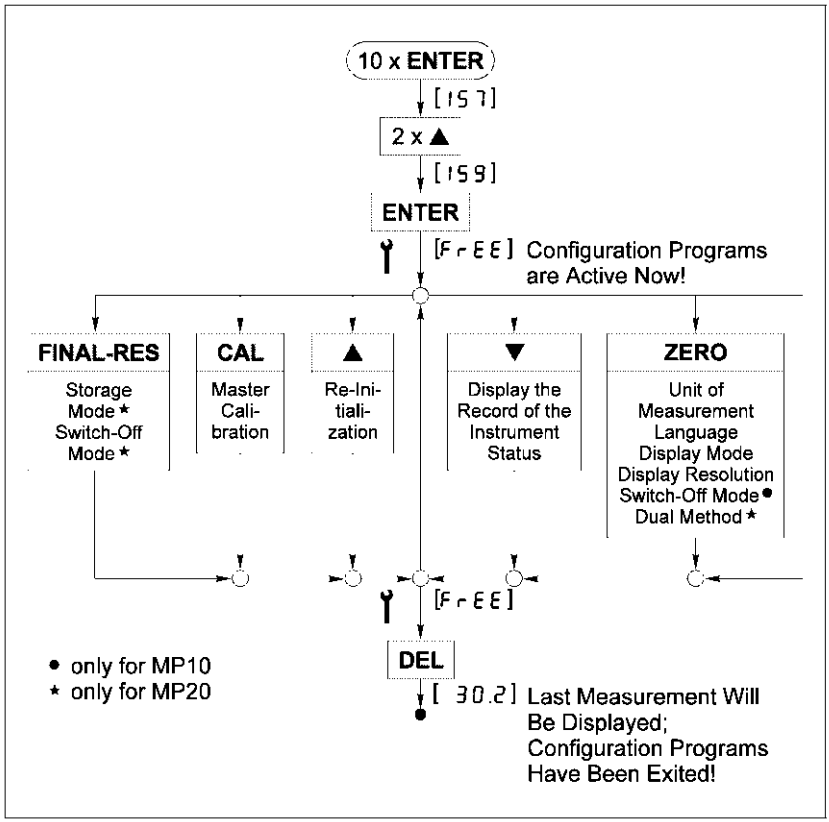


Figure 8.1: Configuration Programs (Overview)

☛ Use ▲ and ▼ to set the parameters of the configuration programs; use **ENTER** to confirm the setting and to step to the next parameter.

8.3.1 Configuration Program FINAL-RES (Storage and Auto Switch-Off Mode) (only with the DUALSCOPE® MP20)

☛ Since the DELTASCOPE® MP10 and the ISOSCOPE® MP10 do not have the key **FINAL-RES**, the configuration program FINAL-RES can be selected only with the DUALSCOPE® MP20!

Keys	Explanation
FINAL-RES	Select the configuration program FINAL-RES by pressing **FINAL-RES.** Select the desired storage mode by pressing ▲ or ▼ : [Storage mode store]: measurements are stored (and remain stored when switching the instrument off) [Storage mode delete at off]: all measurements are deleted when switching the instrument off
ENTER	Confirm the selection with **ENTER.** Select the desired switch off-mode by pressing ▲ or ▼ : [Auto. switch off On]: the instrument switches itself off, if no measurement is taken and no key is pressed for approximately three minutes (auto switch-off mode enabled) [Auto. switch off Off]: the instrument does not switch itself off (auto switch-off mode disabled)

8.3.2 Configuration Program CAL (Master Calibration)

Keys	Explanation
CAL	Select the configuration program CAL by pressing **CAL.** Perform the master calibration with connected probe. (Performing a master calibration: → "6.4 Master Calibration", from page 37).

8.3.3 Configuration Program ▲ (Re-Initialization)

Re-initialization: Restoring the default factory settings of the instrument.

☛ **When re-initializing the instrument, all measurements will be deleted.**

☛ In addition, all settings of the configuration programs are reset to the default factory settings as well. The parameters have to be changed again if required.

Keys	Explanation
▲	Select the configuration program ▲ by pressing ▲ . [Initialize unit? Yes:DEL No:ENTER]: press **DEL** to re-initialize the instrument, or press **ENTER** to exit without re-initializing
DEL	Press **DEL** only if the re-initialization is indeed desired. The re-initialization will be performed automatically. [FrEE] appears automatically. [Exit: DEL]: press **DEL** to exit the configuration programs
DEL	Exit the configuration programs by pressing **DEL**. [not ready]: the instrument is not ready to use
2 x ON/OFF	Switch the instrument OFF and ON again. The instrument is ready to use again.

8.3.4 Configuration Program ▼ (Display the Record of the Instrument Status)

Keys	Explanation
▼	Select the configuration program ▼ by pressing ▼. Display the first line of the instrument status record. [Software version]: instrument software version
ENTER	Display the next line of the instrument status record. [internal state]: internal instrument status
ENTER	Display the next line of the instrument status record. [Probe]: connected probe
ENTER	Display the next line of the instrument status record. [Serial number]: serial number of the connected probe
ENTER	Display the next line of the instrument status record. [Meas. range]: measuring range of the connected probe
ENTER	Display the next line of the instrument status record. [TKFK]: temperature coefficient of of the connected probe

ENTER Display the next line of the instrument status record.

[Storage mode]: selected storage mode (displayed only with the DUALSCOPE® MP20; selecting the storage mode: → "8.3.1 Configuration Program FINAL-RES", page 51)

ENTER Display the next line of the instrument status record.

[Auto. switch off]: selected auto switch-off mode

(Selecting the auto switch-off mode:

for MP10: → "8.3.5 Configuration Program ZERO", page 54

for MP20: → "8.3.1 Configuration Program FINAL-RES", page 51)

ENTER Display the next line of the instrument status record.

[Unit of meas.]: selected unit of measurement (selecting the unit of measurement: → "8.3.5 Configuration Program ZERO", page 54)

ENTER Display the next line of the instrument status record.

[Language]: selected language (selecting the language: → "8.3.5 Configuration Program ZERO", page 54)

ENTER Display the next line of the instrument status record.

[Display]: selected display mode (selecting the display mode: → "8.3.5 Configuration Program ZERO", page 54)

ENTER Display the next line of the instrument status record.

[Dualmethod]: selected dual method (is displayed only with the DUALSCOPE® MP20 if a dual probe is connected; selecting the dual method: → "8.3.5 Configuration Program ZERO", page 54)

8.3.5 Configuration Program ZERO (Unit of Measurement, Language, Display Mode, Display Resolution, Auto Switch-Off Mode, Dual Method)

Keys	Explanation
ZERO	Select the configuration program ZERO by pressing **ZERO**. Select the desired unit of measurement with ▲ or ▼ : [Unit of meas. metric]: unit of measurement µm or mm [Unit of meas. inch units]: unit of measurement mils
ENTER	Confirm the selection with **ENTER**. Select the language for prompt lines with ▲ or ▼ : [Language deutsch]: German [Language english]: English [Language français]: French [Language italiano]: Italian [Language español]: Spanish
ENTER	Confirm the selection with **ENTER**. Select the display mode by pressing ▲ or ▼ (display modes (overview): → "4.1.2 Display Modes", page 19): [Display Coating thickn.]: the coating thickness measurement value will be displayed [Display Xn and Xs]: in addition to the normalized probe output signal of the measurement the saturation probe output signal will be displayed [Display th and Xs]: in addition to the coating thickness measurement value the saturation probe output signal will be displayed [Display Countrate]: in addition to the first four figures of the probe output signal all figures of the probe output signal will be displayed [Display norm. Countrate]: the normalized probe output signal of the measurement will be displayed

ENTER Confirm the selection with **ENTER** (and delete measurements with **DEL** if required to change the display mode).
Select the display resolution by pressing ▲ or ▼:

[Disp. resolution]: use the arrow keys to select the display resolution

[medium] / [low] / [high]: resolution: medium / low / high (the measurement value 73.29, for example, will be displayed as 73 if low resolution is selected, as 73.3 if medium resolution is selected and as 73.29 if high resolution is selected)

ENTER Confirm the selection with **ENTER**.
Select the desired auto switch off-mode with ▲ or ▼ (this option is displayed only with the DELTASCOPE® MP10 and ISOSCOPE® MP10):

[Auto. switch off On]: the instrument switches itself off, if no measurement is taken and no key is pressed for approximately three minutes (auto switch-off mode enabled)

[Auto. switch off Off]: the instrument does not switch itself off (auto switch-off mode disabled)

ENTER Confirm the selection with **ENTER**.
Select the dual method for the connected probe by pressing ▲ or ▼ (this option is displayed only with the DUALSCOPE® MP20 if a dual probe is connected):

[Dualmethod both]: both test methods can be used to measure with the connected probe

[Dualmethod NC/NF]: only the eddy current test method can be used to measure with the connected probe

[Dualmethod NF/Fe]: only the magnetic induction test method can be used to measure with the connected probe

For Your Notes.

9 Errors and Display Messages

9.1 Errors

Error	Possible Cause	Solution
No display	Instrument not switched on	Switch on the instrument with **ON/OFF**
	Instrument switched itself off automatically	Switch on the instrument with **ON/OFF**
	Battery discharged	Replace the battery
No change of the display after pressing **ZERO** or **CAL**	Restricted operating mode enabled	With the instrument switched off disable the restricted operating mode with **ON/OFF + ENTER**
Configuration programs cannot be called-up	Restricted operating mode enabled	With the instrument switched off disable the restricted operating mode with **ON/OFF + ENTER**

Error	Possible Cause	Solution
Probe does not measure	Calculation of the coating thickness is impossible because the coating is too thick	Use measuring object with a thinner coating
	Wrong substrate (measurement with magnetic induction probes is possible only on ferromagnetic substrates)	Use measuring object with ferromagnetic substrate
	Wrong dual method selected (measurements with a dual probe on non-ferromagnetic substrates are not possible if [Dualmethod NF/Fe] has been selected in the configuration program ZERO	Use measuring object with ferromagnetic substrate or select [Dualmethod both] in the configuration program ZERO
	Probe defective	Replace probe

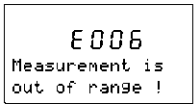
Error	Possible Cause	Solution
Erroneous measurements	Probe not placed correctly on the measuring object (e. g probe hovers above the measuring object)	Place probe correctly on the measuring object
	Wrong substrate (measurement with eddy current probes is possible only on non-ferromagnetic substrates)	Use measuring object with non-ferromagnetic substrate
	Conductive metal near the measuring area when measuring with eddy current probes (e. g. on the backside of a plated circuit board)	Use measuring object without conductive metal
	Wrong dual method selected (correct measurements with a dual probe on ferromagnetic substrates are not possible if `[Dualmethod NC/NF]` has been selected in the configuration program ZERO	Use measuring object with non-ferrous substrate or select `[Dualmethod both]` in the configuration program ZERO
	Erroneous normalization or calibration	Perform the normalization or calibration correctly
	Probe tip(s) worn	Have probe tip(s) replaced by the Fischer service department

9.2 Display Messages

Detail of the Display	Explanation / Possible Cause	Solution
- - - -	Measurement cannot be displayed (since the value is larger than 9999 or smaller than -9999) Cause: measurement was not performed correctly	Perform the measurement correctly (e. g. do not hover with the probe over the measuring object before or after the measurement)
	Cause: the eddy current probe, which is normalized now on non-ferromagnetic substrate, was normalized before on ferromagnetic substrate	Continue normalization
not ready	Instrument is not ready to use Cause: re-initialization has been performed	Switch the instrument off and on again using **ON/OFF**

9.2.1 Error Messages and Warnings

The error messages (E ***) and warnings (U ***), that may occur during operation of the instrument, are included in the overview on the following pages.

Detail of the Display	Explanation / Possible Cause	Solution
	Internal error	Switch the instrument off and on again with **ON/OFF** If the error occurs repeatedly, call the Fischer service department
	Overflow of the internal memory	Delete the stored measurements
	Measurement cannot be displayed since it is out of the measuring range of the connected probe Cause: coating too thick	Perform measurements on a measuring object with a coating thickness measurable with the connected probe or replace the probe
	Cause: measurement was not performed correctly	Perform the measurement correctly (e. g. do not hover with the probe over the measuring object before or after the measurement)
	Cause: measurement was performed with an eddy current probe on non-ferromagnetic substrate after normalization on ferromagnetic substrate	Perform the normalization with the eddy current probe on non-ferromagnetic substrate and repeat the measurement

Detail of the Display	Explanation / Possible Cause	Solution
E007 Measurements invalid !	Outlier measurement was recognized during normalization or calibration Cause: measurement on the calibration standard was not performed correctly	Repeat the calibration step and perform the measurements correctly (e. g. do not hover with the probe over the measuring object before or after the measurement)
	Cause: measurements were performed on the wrong calibration standard (e. g. one measurement was performed on the uncoated substrate instead of the calibration standard)	Repeat the calibration step and perform the measurements on the proper calibration standard
E010 Meas. method not supported !	The connected probe is not suitable (the test method of the connected probe does not correspond to the instrument model, e. g. a magnetic induction probe is connected to an ISOSCOPE® MP10 or an eddy current probe is connected to a DELTASCOPE® MP10)	Connect a suitable probe
	Probe defective	Replace probe

Detail of the Display	Explanation / Possible Cause	Solution
E 0 1 1 Measurement is out of interval!	Corrective calibration cannot be terminated Cause: measurement was not performed correctly	Repeat the corrective calibration and perform the measurements correctly (e. g. do not hover with the probe over the measuring object before or after the measurement)
	Cause: the coating thickness of the calibration standards used is not suitable or the calibration standards are defective	Repeat the corrective calibration with proper calibration standards
	Cause: normalization was performed on a calibration standard instead of the uncoated measuring object	Repeat the corrective calibration and perform the normalization on the uncoated measuring object
E 0 1 2 Invalid std. sequence !	Calibration standards were measured in the wrong sequence during corrective calibration (standard 1 was interchanged with standard 2) and the foil thicknesses were not set correspondingly	Repeat the corrective calibration and measure the calibration standards in the correct sequence

Detail of the Display	Explanation / Possible Cause	Solution
E 0 13 Countrate is out of interval !	Master calibration cannot be ended Cause: measurement was not performed correctly	Repeat the master calibration and perform the measurements correctly (e. g. do not hover with the probe over the measuring object before or after the measurement)
	Cause: the coating thickness of the calibration standards used is not suitable or the calibration standards are defective	Repeat the master calibration with proper calibration standards
	Cause: normalization was performed on a calibration standard instead of the uncoated measuring object	Repeat the master calibration and perform the normalization on the uncoated measuring object
E 0 14 Unable to calc. parameters !	Internal error: the coefficients of the master calibration curve cannot be calculated (the previous master calibration curve will not be changed)	Repeat the master calibration If the error occurs repeatedly, call the Fischer service department

Detail of the Display	Explanation / Possible Cause	Solution
E015 Unable to store cal. in probe !	Master calibration parameters cannot be stored Cause: the probe connector is not plugged correctly into the receptacle or the locking ring was not tightened	Plug-in the probe correctly, tighten the locking ring and repeat the master calibration
	Cause: probe defective	Replace the probe and repeat the master calibration if required
E016 Std. and meas. not matching !	The foil thicknesses stored and the thicknesses measured do not match Cause: calibration standards were measured in the wrong sequence during master calibration (e. g. standard 1 was interchanged with standard 2) and the foil thicknesses were not set correspondingly	Repeat the master calibration and measure the calibration standards in the correct sequence
E021 Standard invalid !	Corrective calibration is not possible with the entered foil thickness (e. g. because [Cal.Std. 2: 0] has been entered)	Set the foil thickness of the calibration standard used and continue the corrective calibration

Detail of the Display	Explanation / Possible Cause	Solution
E022 Missing probe !	No probe is connected	Connect a probe
	Probe was not connected correctly	Connect the probe correctly
	Probe defective	Replace probe
E999 System error !!!	Internal error	Call the Fischer service department
U003 Options corrected !	Erroneous settings were corrected automatically by the instrument	
U004 Action canceled !	An action was canceled (e. g. a corrective calibration was canceled with **ENTER**)	Repeat the action if required
U005 1 point calibration !	The difference of the thicknesses of the two calibration standards the corrective calibration was performed with, is not large enough (will be treated as one-point calibration)	Perform the corrective calibration with suitable calibration standards (the difference between the normalized countrates of the standards has to be larger than 0.1: $Xn_{\text{Cal. Std 2}} - Xn_{\text{Cal. Std 1}} = \Delta Xn > 0.1$)

Detail of the Display	Explanation / Possible Cause	Solution
	Another probe was used last for measuring with this instrument	Connect the probe used last for measuring or check the normalization and corrective calibration of the connected probe by reference measurement and re-normalize or recalibrate if required

For Your Notes.

10 Technical Data and Contents of Shipment

10.1 Technical Data

Instrument models:	DELTASCOPE® MP10, ISOSCOPE® MP10 and DUALSCOPE® MP20
Display:	LC display with symbols and prompts to guide the user
Measurable coatings:	Non-ferromagnetic or non-conductive coatings on steel or iron (magnetic induction test method according to DIN EN ISO 2178 (/ 7 /), BS 5411/11 (/ 13 /) or ASTM B499 (/ 12 /)) (with DELTASCOPE® MP10 and DUAL-SCOPE® MP20)
	Non-conductive coatings on non-ferromagnetic substrates (eddy current test method according to DIN EN ISO 2360 (/ 8 /), BS 5411/3 (/ 13 /) or ASTM B244 (/ 11 /)) (with ISOSCOPE® MP10 and DUALSCOPE® MP20)
Dimensions:	Instrument: 160 mm x 80 mm x 30 mm (L x W x H) 6.3" x 3.1" x 1.2" (L x W x H)
	Display: 60 mm x 30 mm (L x B) 2.4" x 1.2" (L x B)
Weight:	250 g (0.55 lbs)
Admissible ambient temperature range during operation:	5 ... 45 °C (41 ... 113 °F)
Admissible storage temperature:	5 ... 60 °C (41 ... 140 °F)
Admissible environmental relative humidity during operation:	30 ... 90 % (non-condensing)

Measuring range:	Depending on the connected probe
Trueness:	Depending on the connected probe
Repeatability:	Depending on the connected probe
Accuracy:	Depending on the connected probe
Power supply:	9 V battery (6LR61) for up to 25 hours of operation or 9 V rechargeable NiCd battery for up to 5 hours of operation (battery can be recharged with the plug-in type battery charger)
Power consumption:	0.2 W
Receptacles:	Probe: 8-pin round plug

10.2 Contents of Shipment and Options

Shipping container and contents should be checked for possible damages immediately after receipt of the shipment. If the packaging and the instrument or the accessories are damaged, the packaging should be kept. It may be needed as proof when making damage claims with the carrier.
We recommend to keep the packing material for possible future use when moving or shipping the instrument.

Also check if all components of the standard contents of shipment and options ordered are included in your shipment. Contact your local supplier or Fischer if the shipment is incomplete.

10.2.1 Standard Contents of an Instrument Shipment

The standard contents of an instrument shipment includes:

- instrument in a protective plastic cover and battery
- carrying and storage case
- operator manual and short-form operator manual

10.2.2 Standard Contents of a Probe Shipment

The standard contents of a probe shipment includes:

- measuring probe
- probe-specific set of calibration standards
  (consisting of two calibration standards for the corrective calibration (corrective foils) and an uncoated test piece for functional testing purposes (Fe or Al base depending on the probe))

10.2.3 Options

The following options are available:

- foils for calibration purposes and for reference measurement purposes (for checking calibrations)
- probe-specific set of calibration standards for the master calibration (master foils)
- additional probes
- 9 V rechargeable NiCd battery
- 9 V alkaline battery
- plug-in type battery recharger
- desk top support for hand-held instruments
- V12 measuring stand for reproducible probe positioning
- magnetic slide table for V12 measuring stand
- quick loading screw fixture for V12 measuring stand to mount and measure metric and sheet metal screws
- adapter for mounting right angle probes on the V12 measuring stand (e. g. for probe EGABW 1.3)
- adapter for mounting inside probes on the V12 measuring stand (e. g. for probe EGABI1.3-150 mm)
- motorized V12 measuring stand for automatic placement and lifting of probes

For Your Notes.

11 Glossary of Terms and Symbols

This chapter explains the most common terms and symbols in coating thickness measurement and related fields (e. g. quality assurance). In some cases, alternate terms or synonyms are mentioned in parentheses.

Accuracy: Difference between the average result of a measurement with a particular instrument and the true value of the quantity being measured. Usually, accuracy is divided into ➞ *Trueness* and ➞ *Precision*.

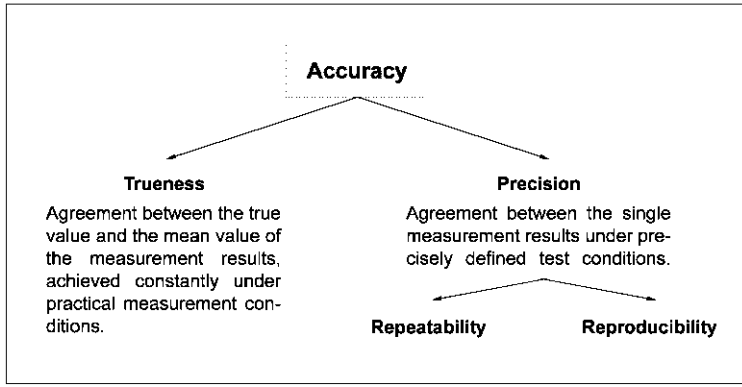


Figure 11.1: Accuracy

Application: Measurement application of the user.

Attributive features: ➞ *Features*

Base: Uncoated test piece for functional testing purposes.

Calibration curve (characteristic): Quantitative relationship between the probe signal and a function of the coating thickness as defined by calibration standards.

The mid portion of the calibration curve (see figures 11.2 and 11.3) approaches a straight line. This is the range with the smallest relative measurement error.

As long as no normalization or corrective calibration has been performed, the calibration curve is identical with the master calibration curve. During normalization or corrective calibration the calibration curve is adjusted to the individual measurement application and the coefficients of the normalization or corrective calibration are stored in the EEPROM memory chip of the probe connector.

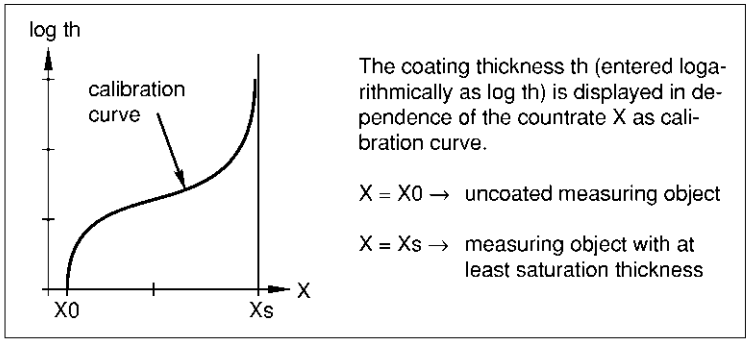


Figure 11.2: Calibration Curve
(Coating Thickness as a Function of the Countrate)

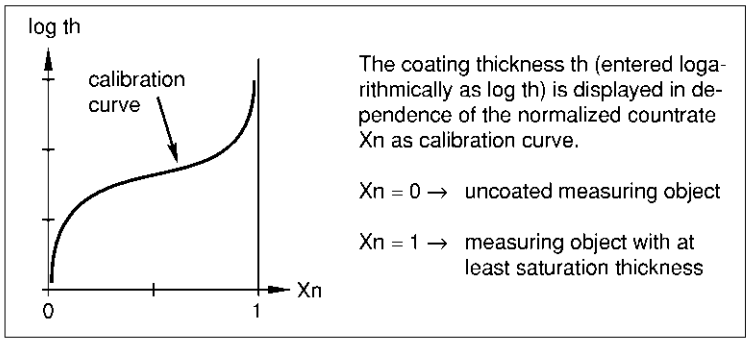


Figure 11.3: Calibration Curve
(Coating Thickness as a Function of the Normalized Countrate)

Calibration foils: Calibration standards in form of foils with known thickness. When calibrating with an MP10 or MP20, the coating is simulated by the foil, which is placed on the uncoated measuring object (i. e. the substrate).

Calibration standards: Objects with the same attributes (or as close as possible) as the measuring object with known coating thicknesses. The coating thickness of the calibration standards has been measured with an extremely accurate test method.

Characteristic: → *Calibration curve*

Comparative sample: → *Reference sample*

"Continuous" display mode: With the probe placed on the measuring object, measurements will be displayed continuously. Will be indicated by ↻ in the display of the MP10 and MP20.

Control chart: → *Process control chart*

Control limits: If the measurements are entered in a process control chart, there is no need for process control measures, if the measured quantity lies within the range defined by control limits.

Corrective calibration (one-point or two-point calibration): Adjustment of the instrument using an uncoated measuring object and one or two calibration standards. The corrective calibration includes calibration and adjustment.
During corrective calibration the calibration curve is adjusted to the individual measurement application. The coefficients of the adjusted calibration curve are stored in the EEPROM of the probe connector.
The coefficients of the master calibration curve, which are stored in the EEPROM of the probe connector, remain unchanged.

Countrate: Digitized form of the measurement signal, which is proportional to the coating thickness. The measurement signal is produced in the probe by the coating to be measured. The thicker the coating is, the larger is the countrate. However if the coating has saturation thickness, an additional increase in coating thickness will no longer produce an increase in the measuring effect. (Continued on next page.)
→ *Saturation thickness* / → *Calibration curve*

Countrate (continuation): The numeric values of the **normalized countrate** *Xn* range between 0 and 1, and are calculated according to the following equation:

$$Xn = \frac{X - X0}{Xs - X0}$$

with: *X* countrate measured on the coated measuring object
X0 countrate measured on the uncoated measuring object
Xs countrate measured on a measuring object with at least saturation coating thickness

Cumulative frequency distribution: A form of display of the measurement data distribution, such that the number of measurements smaller or equal to a particular measurement is calculated and displayed in percent.

Cumulative frequency distribution chart: ➙ *Normal probability chart*

Display: The display of the MP10 or MP10 is large, neatly arranged and includes a multitude of symbols to indicate the instrument status and prompts to guide the user.

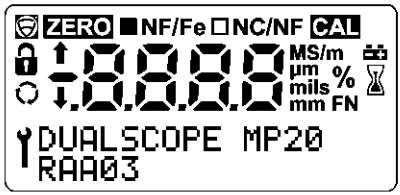


Figure 11.4: Display of the DUALSCOPE® MP20

Dual probe: Dual probes can be used to measure coating thickness according to the magnetic induction test and eddy current test method. When placing the probe on the measuring object, the test method suited for the coating-substrate-combination will be automatically selected.

EEPROM (Electrically Erasable Programmable Read Only Memory): Advanced EPROM.

Evaluation: Calculation of statistical parameters, e. g. mean value or standard deviation. With the DUALSCOPE® MP20, the evaluation can be called-up with the key **FINAL-RES**.

Features: Properties of a product.

Variable features are the measurable property of a product subject to change or variability. Coating thickness is a variable feature.

Attributive features are the properties of a product that usually cannot be captured by taking measurements. Examples are, deviations in color, or whether the product is true to gauge size.

Gaussian normal distribution: ➙ *Normal distribution*

Gaussian probability paper: ➙ *Normal probability chart*

Local coating thickness: The local coating thickness is the arithmetic mean value of the single measurements performed on the reference area.

Master calibration: Adjustment of the instrument using an uncoated measuring object and calibration standards. During a master calibration, the master calibration curve is determined.

The master calibration includes calibration and adjustment.

Master calibration curve (probe characteristic): Characteristic of the measuring system. The master calibration curve is determined during master calibration on smooth, flat substrate material. It is the basis for determination of the measurement values, since it represents the relationship between the coating thickness and the probe signal.

The coefficients of the master calibration curve are stored in the EEPROM memory chip of the probe connector.

Maximum measurement: Largest measurement of a measurement series.

Mean value: ➙ *Th.*

Measurement: Numeric reading of an instrument, expressed in the unit of measurement. The measurement can be obtained as the result of a single measurement or as arithmetic mean of several single measurements.

Measurement accuracy: ➙ *Accuracy*

Measurement application: Structure of the measuring object in terms of its coating, intermediate coating, and substrate material, according to material, thickness and other properties (hard/soft, porous/dense, homogenous/inhomogenous, etc.) and any other conditions relevant to the measurement requirement. These factors determine the selection of a suitable test method and the instrument.

Measurement errors: The difference between the actual and measured value of a measured quantity. For measuring instruments there is a distinction between random (unpredictable) and systematic (correctable) errors. Random errors determine the repeatability precision. Systematic (bias) errors affect the trueness and the reproducibility.
Systematic errors are far more prevalent in practical coating thickness measurement applications (see / 5 / for further details).
Systematic (bias) errors can be traced back to: 1. faulty calibration, 2. operator related errors, or 3. changes in test conditions (inhomogeneities of the substrate, aging, etc.). Systematic (bias) errors tend to lean in one direction. With appropriate care, causes 1 and 2 can usually be avoided or corrected. Causes of the third kind can sometimes be eliminated by using an appropriate correction technique.

Measurement range: → *Measuring range*

Measurement series: A series of single measurements made between two block or final results.

Measurement system check: A significant part of monitoring the test equipment. Calibration standards or, even better, reference samples, are used to check the calibration and to verify the stability of the instrument.

Measuring: Measuring is comparing.
The probe signal generated at the measuring position is compared to the probe signal of the calibration standard. Using the calibration curve, the instrument converts the probe signal to the measurement result.

Measuring method: → *Test method*

Measuring object: Object on which the measurements are to be performed to determine the coating thickness for example.

Measuring position: A limited and clearly defined point within the reference surface of the measuring object where the coating thickness is to be determined. (Detailed information is included in / 6 /.)

Measuring probe: → *Probe*

Measuring range: The range between the two limits within which a measurement is possible at a specified trueness and precision. In a narrower sense, it refers to the range of an analog instrument. The measuring range depends on the test method, the design of the probe, and the measurement application (e. g. because of saturation thickness of the coating material).

Memory: Data storage element of a microprocessor-based measuring instrument. Information is saved in the memory. (→ *Application*)

Method: → *Test method*

Minimum measurement: Smallest measurement of a measurement series.

Monitoring of test equipment: A quality assurance task. It consists of ensuring that the measuring system (instrument) is operating properly and is still calibrated correctly, and to take corrective measures, if necessary (re-calibration of instrument or repair). (→ *Measurement system check*)

Normal distribution (Gaussian normal distribution, Gaussian distribution): Probability distribution, discovered by C. F. Gauß in 1794.

The probability distribution P(X) is symmetrical around the mean value μ of the quantity X, which can be classified as having normal distribution.

If a quantity X can be classified as having normal distribution, 68.3 % of the observed values of X are within the σ-interval (σ - deviation) around the mean value μ of the quantity X, i. e. the following is valid for 68.3 % of the observed values: $\mu-\sigma \leq X \leq \mu+\sigma$. This interval is indicated in figure 11.5 by the grey area below the curve.

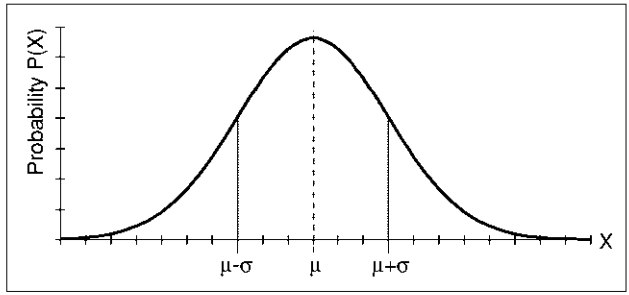


Figure 11.5: Probability Distribution P(X) of a Quantity X, Which can be Classified as Having Normal Distribution

Normal distribution (continuation): The populations, which are tested for technical purposes, often can be classified as having approximately normal distribution.

However, the following fact is of great importance: if several random samples with equal size are drawn of a population, and the mean values of these random samples are determined, these mean values can be classified as having normal distribution (Central Limits Theorem).

The mean value of these sample mean values is an estimated value for the mean value μ of the population.

Whether a quantity can be classified as having normal distribution can be checked in the normal probability chart, since a straight line in the normal probability chart indicates normal distribution.

Normalization: Adjusting a coating thickness measuring instrument to a new zero value (countrate X0). Important for some applications when the substrate changes, or when the test method is subject to instability (e. g. to drift) (e. g. for beta backscatter and X-Ray fluorescence methods). During normalization the calibration curve is adjusted to the individual measurement application, the current application is calibrated for. The coefficients of the adjusted calibration curve are stored in the EEPROM of the probe connector.

The coefficients of the master calibration curve, which are stored in the EEPROM memory chip of the probe connector, remain unchanged.

Normalized Countrate: → *Countrate*

Normalized probe output signal: → *Countrate*

Normal probability chart (Gaussian probability paper, cumulative frequency distribution chart, probability paper): Can be used to check graphically for normal distribution of the measurements. A straight line in the normal probability chart indicates normal distribution.

One-point calibration: → *Corrective calibration*

Outlier measurements: Measurements that are considerable larger or considerable smaller than the other measurements of the measurement series and therefore can be considered as unexpected or unacceptable.

Precision: Agreement between the single measurement results under precisely defined test conditions. The precision is composed of repeatability and reproducibility (→ *Accuracy*; → *Repeatability*; → *Reproducibility*).

Probability paper: → *Normal probability chart*

Probe: The instrument receives the electrical probe signal, which is proportional to the coating thickness measured, from the probe. The probe signal is then converted by means of the calibration parameters into the coating thickness measurement value.
The Fischer E... probes are equipped with a memory chip (EEPROM) in the probe connector. The EEPROM stores probe-specific information (e. g. probe type, manufacturing code, test method and coefficients of the master calibration curve).

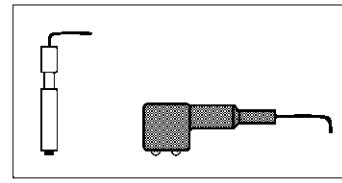


Figure 11.6: Probes
(Axial Single Tip Probe and Double Tip Probe as Example)

Probe characteristic: → *Master calibration curve*

Probe output signal: → *Countrate*

Process control: → *Statistical process control*

Process control chart (SPC chart, quality control chart): Statistical Process Control (SPC) often uses random samples to control a production such that the production process is under statistical control.
To do this, the variable features of the product are entered in a process control chart. Process control charts plot process variation over time and help to identify the causes of variations.
A random sample is taken from the production process and measured. The result (e. g. mean value and standard deviation ($\overline{x}$-s chart)) is graphically documented. The results of the control chart are used to determine when action should be taken in the process.

Quality assurance: All measures taken by a producer to ensure a controlled production process within the established quality criteria. One aspect of it is quality control, specifically, coating thickness measurements where coating thickness limit specifications are involved.

Quality control chart: → *Process control chart*

R: Range R of all measurements being displayed in the process control chart. The range is the difference between the maximum measurement th_{max} and the minimum measurement th_{min} in a measurement series.

$$R = th_{max} - th_{min}$$

Random measurement errors: ➙ *Measurement errors*

Random sample: A representative group selected from the production lot, using random sample principles. The sample is used to determine the properties of the entire lot (batch, unit of production).

Random sample size: Number of parts, combined into a random sample.

Range: ➙ *R*

Reference area: A portion of the significant surface area of a product where one or more measurements are to be taken. It is recommended to include the reference area or significant surface area in the production specifications, in addition to the specifications limits for the coating thickness.

Reference measurement: Measurement on a reference sample to check the normalization or calibration which was performed before.

Reference sample: Measuring object with a known coating thickness on a defined reference area that can be used to check the calibration. The coating thickness within the reference area should be as regular as possible.

The reference sample should have the same properties (substrate material, coating material, geometry, conductivity, etc.) as the measuring object, the calibration is performed for.

The reference samples may be from in-house production or may be from external sources. The coating thickness of a reference sample should have been determined using a reliable and properly calibrated instrument. Reference samples are used for the monitoring of test equipment.

Reference samples are subject to wear and tear caused by the tactile measurement. The wear and tear is dependent on the coating material and on the probe which used for measurement. For this reason, reference samples have to be checked regularly and replaced by new reference samples if the wear and tear becomes significant.

Repeatability: The standard deviation of the measurements taken under repeatability conditions is a measure for the repeatability. The smaller the standard deviation of these measurements, the better is repeatability.

The repeatability is dependent on the test method and the quality of the instrument, but often also on the properties of the measuring object (for instance, surface roughness).

The standard deviation of the measurements under repeatability conditions can be reduced by generating the mean value of the measurements. ➞ *Accuracy*

Reproducibility: The ability of different operators to achieve practically the same measurement result, when taking measurements with different instruments at the same measuring position of the same measuring object at different locations. ➞ *Accuracy*

Right value: ➞ *Trueness*

s: The standard deviation s is a measure of the deviations of single measurements of a measurement series from their common mean value.

The mean square deviation of the single measurements from the mean mean value is calculated as follows:

$$s = \sqrt{\frac{(th.-th_1)^2 + (th.-th_2)^2 + \ldots + (th.-th_N)^2}{(N-1)}}$$

$$s = \sqrt{\frac{1}{(N-1)} \cdot \sum_{i=1}^{N} (th.-th_i)^2}$$

with: $th.$ mean value of the single measurements
th_i single measurement
N number of measurements

Figure 11.7 demonstrates that two measurement series with different standard deviations can still have the mean value.

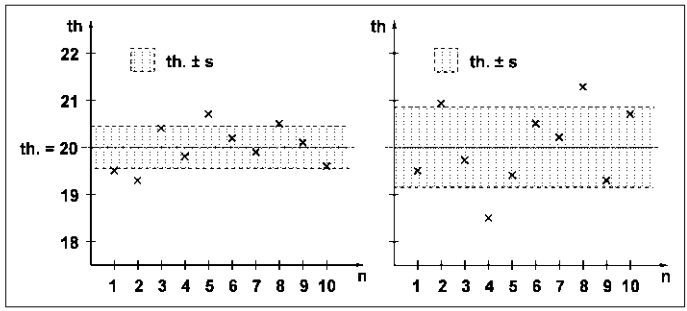


Figure 11.7: Measurement Series with the Same Mean Value but Different Standard Deviation

Saturation countrate: Countrate measured on a coating with at least saturation thickness. ➞ *Countrate*

Saturation thickness: The thickness of a coating where an additional increase in coating thickness no longer produces a change in the probe signal. It determines the end of the measuring range for a particular application or test method. When measuring near the saturation thickness, the uncertainty of measurement is usually largest.

Significant surface: Area on the surface of a measuring object containing the the coating to be measured. All properties necessary for the use and appearance of the product must occur at this significant area.

Single measurement: ➞ *Single reading*

Single reading: Measurement result as displayed by the instrument after a single measurement at the measuring position.

SPC: Statistical Process Control. ➞ *Statistical process control*

SPC chart: ➞ *Process control chart*

Specifications: Requirements according to which production is defined within certain limits for variable and attributive properties, like for instance the lower and the upper specification limit for the coating thickness. Quality control monitors adherence to these requirements.

Specimen: ➞ *Measuring object*

Stability: As with every process, test methods are also subject to deviations. This may lead to systematic measurement errors (e. g. drift), independent of handling. By examining the stability and by regular checks, one can ensure stability.

Standard: → *Calibration standard*

Standard deviation: → *s*

Statistical process control (SPC): A statistical method to analyze and control the quality of a process. In high volume productions, only random samples are taken instead of 100% inspection which would be too costly. The measurement results of the random samples are extrapolated for the entire production lot with mathematical-statistical methods, and then used to control the production process.
This modern method of quality control ensures constant good quality, with a minimum level of rejected parts.
Normal distribution of the measurements is required so that statistical process control can be used for quality control purposes.

Substrate material: For some applications or measuring methods, the properties of the substrate material and the geometry of the measuring object influence the result significantly. In these cases, it is important to take these influences into account through normalization, before measuring.
For coating thickness measurement, the substrate material always refers to the actual uncoated measuring object.

Systematic measurement errors: → *Measurement errors*

Test method: Procedures and process to obtain information about the properties of a measuring object. The test method is based on scientific findings and depends on the application. In the field of coating thickness measurement, the test method must be able to distinguish the coating to be measured from all other coatings and the substrate material, in order to make the measurement possible.
(For further details, see / 10 /.)

Th.: Mean value. Arithmetic mean value *Th.* of a measurement series consisting of *N* single readings Th_i, according to the equation

$$th. = \frac{(th_1 + th_2 + \ldots + th_N)}{N} = \frac{\sum_{i=1}^{N} th_i}{N}$$

with: th_i single reading
N number of single readings evaluated

Trueness: Agreement between the true value and the mean value of the measurement results, achieved constantly under practical measurement conditions. ➞ *Accuracy*
The true value is a value known from mathematical theoretical formulations. Since such values are seldom encountered, a value deduced from national or international standards is taken as "right". This right value is often indicated as true value.

True value: ➞ *Trueness*

Two-point calibration: ➞ *Corrective calibration*

Unit of measurement: Unit used for the measurement display. In coating thickness measurement, the common unit of measurement in the metric system is the µm (micrometer = 1/1000 mm) or in the US-system it is the mil (1/1.000 inch ≈ 0.0254 mm = 25.4 µm).

Variable features: ➞ *Features*

X: Countrate. ➞ *Countrate*

X0: Zero point of the calibration curve. Countrate obtained when measurements are taken on the uncoated measuring object (substrate material). ➞ *Countrate*

Xn: Normalized countrate. ➞ *Countrate*

Xs: Saturation countrate. Countrate obtained when measurements are taken on a coating of at least saturation thickness. ➞ *Countrate*

12 Additional Literature

12.1 Statistics and Coating Thickness Measurement

/ 1 / DataMyte Corporation: DataMyte Handbook - A practical guide to computerized data collection for Statistical Process Control

/ 2 / Duncan, Acheson J.: Quality Control and Industrial Statistics; Homewood Illinois: Richard D. Irwin, Inc.

/ 3 / Ford Q-101: Quality System Standard

/ 4 / Helmut Fischer GmbH + Co: Reports

12.2 Standards

/ 5 / DIN 1319: Basic concepts of measurement; concepts for uncertainty of measurement and for evaluation of measuring instruments

/ 6 / DIN EN ISO 2064: Metallic and other non-organic coatings - Definitions and conventions concerning the measurement of thickness

/ 7 / DIN EN ISO 2178: Non-magnetic coatings on magnetic substrates - Measurement of coating thickness - Magnetic method

/ 8 / DIN EN ISO 2360: Non-conductive coatings on non-magnetic substrates - Measurement of coating thickness - Eddy current method

/ 9 / ISO 3534: Statistics; Vocabulary and Symbols

/ 10 / DIN EN ISO 3882: Metallic and other non-organic coatings - Review of methods of measurement of thickness

/ 11 / ASTM B 244: Standard method for measurement of thickness of anodic coatings on aluminum and of other non-conductive coatings on nonmagnetic basis metals with eddy-current instruments

/ 12 / ASTM B 499: Standard test method for measurement of coating thicknesses by the magnetic method: nonmagnetic coatings on magnetic basis metals

/ 13 / BS 5411: Methods of test for metallic and related coatings
Part 3: Eddy current method for measurement of coating thickness of non-conductive coatings on non-magnetic basis metals
Part 11: Measurement of coating thickness of non-magnetic metallic and vitreous or porcelain enamel coatings on magnetic basis metals: magnetic method

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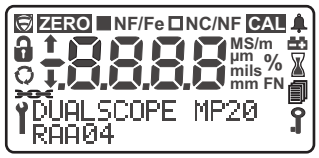
For Your Notes.

Short-Form Operator Manual DELTASCOPE® MP10E, ISOSCOPE® MP10E and DUALSCOPE® MP20E

Display



	Fischer trademark
ZERO	Normalization is performed
■NF/Fe	Measurement using the magnetic induction test method is performed
□NC/NF	Measurement using the eddy current test method is performed
CAL	Calibration is performed
	Restricted operating mode has been selected
	"Continuous" display mode has been enabled
-8888	Measurement values, error messages and warnings
MS/m µm % mils mm FN	Unit of measurement of the displayed value
	Internal routine is performed
	Battery has to be changed or recharged
	Configuration programs have been called up
...SCOPE	Instrument type
RAA...	Instrument software version

Measurement and Evaluation:

Performing a Measurement:

1. Switch the instrument on: **ON/OFF**
2. Measuring: Place the probe vertically on the measuring object

Deleting Measurement Values:

DEL (last value) ➛ **DEL** (all values)

"Continuous" Display Mode:

Move the probe over a surface area to determine the coating thickness distribution.
Enabling: ▼ ➛ ◌ appears; **Disabling**: ▼

Evaluation (only with MP20E):

FINAL-RES ➛ ... ➛ **FINAL-RES** ➛ **ENTER** (exit the evaluation and delete all the measurements) or ▲ (exit the evaluation without deleting the measurements)

Normalization / Corrective Calibration:

Normalization:

ZERO ➛ perform several measurements on the substrate material ➛ **ENTER**

Corrective Calibration:

1. **CAL** ➛ perform several measurements on the substrate material ➛ **ENTER**
2. Place standard 1 (foil 1) on the substrate material ➛ perform several measurements on the standard 1 (foil 1)
3. Set the foil thickness with ▲, ▼ ➛ **ENTER**
4. If a 2 point calibration is desired: Place standard 2 (foil 2) on the substrate material ➛ perform several measurements on foil 2 ➛ set the foil thickness with ▲, ▼; otherwise: after step 3 immediately step 5
5. **ENTER**

Symbols and Styles Used

ENTER	Refers to instrument keys, which have to be pressed
ZERO ➛ perform	Refers to instrument keys or actions, which have to be pressed or performed one after the other
ON/OFF + ▲	Refers to instrument keys, which have to be pressed immediately one after the other (do not keep both keys pressed!)

☛ For more detailed information please refer to the operator manual MP10E and MP20E!

Configuration

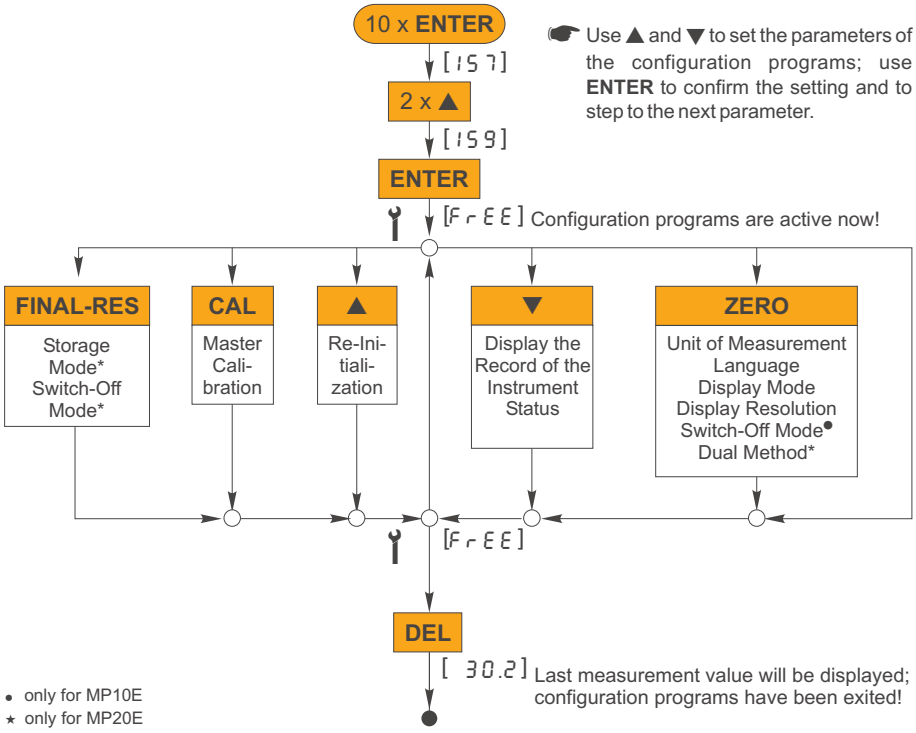
Acoustic Measurement Accept Signal:

Enabling: **ON/OFF + ▲**
Disabling: **ON/OFF + ▼**

Restricted Operating Mode:

Enabling: **ON/OFF + DEL** (🔒 appears)
Disabling: **ON/OFF + ENTER**

Overview of the Configuration Programs:



Use ▲ and ▼ to set the parameters of the configuration programs; use **ENTER** to confirm the setting and to step to the next parameter.

• only for MP10E
⋆ only for MP20E

 Subject to change. 902-586 Version 1.3 - 11/05

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For more detailed information please refer to the operator manual MP10E and MP20E!

- **Notes concerning the use of hand-held instruments**

Caution!

We recommend removing the batteries if the instrument is not used for an extended period of time to avoid serious damage from battery leakage.

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